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VOLCANOES OF NORTH AMERICA.

Volcanoes of North America; a Reading Lesson for Students of Geography and Geology. By Israel C. Russell, Professor of Geology, University of Michigan, Pp. xiv + 346. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1897.)

PROF. RUSSELL'S beautiful volume is, in some sense, a companion to Sir Archibald Geikie's account of the volcanoes of Great Britain; but whereas the latter deals with volcanic relics of all ages in an area the whole of which has been studied in considerable detail, the former has to do only with still active volcanoes, or such as have been in activity since the beginning of the Tertiary era, while in many of the districts dealt with but little scientific information is available.

The first chapter contains a most useful summary of the general characteristics of volcanic action all the world over, culled from the work of authorities like Judd, Palmieri and Shaler, Verbeek, Dutton and Dana, followed by an account of the shape and structure of cones, and the different rock products formed by volcanic action. American volcanoes do not enter much into this account, but touches of local colour are not altogether absent, for we learn that "while Vesuvius is regarded as a very obstreporous volcanic vent, its performances are mere Fourth of July fireworks in comparison with the Day of Judgment proceedings of Krakatoa."

In dealing with masses of intrusive rocks the author distinguishes between dykes, sills, laccolites, plugs, and *subtuberant* mountains, the last term applying to great sculptured domes like the Black Hills of Dakota, known to be based in an enormous core of granite which appears to have slowly increased in bulk like "the growth of a tuber in the earth" and lifted the sediments upon its back.

The next three chapters are devoted to the volcanoes of North and Central America. The author does not appear to have visited Central America, Mexico, or Alaska north of Cook's Inlet, and in his description he is further hampered by the absence in many cases of recent or trustworthy scientific information. Considering this disadvantage the account given is a very useful one, and as much care has been taken to exclude untrustworthy information as to make the most of what is good. In spite of Humboldt's authority, Prof. Russell thinks the story that Jorullo arose in a night is not worthy of credence. Izalco, in Central America, however, appears to have acquired its total height of 3000 feet above the surrounding country since 1770.

Passing on to the volcanoes of the United States, Prof. Russell at once finds himself at home and amongst examples which he has personally studied. His account becomes more graphic and full of the results of close and careful observation. Beautiful examples of denuded rocks standing as columnar rock pillars are associated with the lava sheets forming "mesas" or plains about Mount Taylor in New Mexico. The oddly-named Ice-Spring Craters in Utah seem as perfect as those of Auvergne, and illustrate some strange phases of eruption. The lake of molten lava in one of the craters appears to have slowly risen to a considerable height before breaking out an exit for itself, and relics of its former levels still exist in five terraces inside the crater ring. One of the lavas, too, though lying in a depressed channel, evidently "spread beyond its channel like an aqueous stream, and deposited, not its sediment, but its crust."

Many interesting features of the craters near and in Monro Lake, California, are described; but we have only room for one or two of the observations. Granite pebbles occur in the tuffs, evidently thrown up from a gravel sheet through which the volcano burst; one of the lava streams when looked at from above is seen to have its scoria ridges arranged like curved terminal moraines; the lavas are mainly obsidians, and remain as plugs, more or less filling some of the craters, and even in certain instances rising higher than the crater rim without overflowing; where it did outflow, the lava was highly viscous, and was pushed forward in thick sheets, terminating in precipices between 200 and 300 feet high. The beautiful cone of Mount Shasta in California, of which a picture is given, has not been long extinct, for its most recent lavas are not glaciated. Yet one of them entered the cañon of the Sacramento River, reaching a distance of fifty miles, and the river has since cut through this barrier and excavated a narrow gorge more than a hundred feet deep in the rocks beneath. A still more remarkable case of erosion is quoted from an extinct volcano near Fort Union in New Mexico, where a lava filled up the Mora cañon to a depth of 400 feet. The river has re-excavated this channel, and cut down 230 feet into the rock beneath. "The time required for Niagara to cut its gorge . . . has been variously estimated at from 7000 to 35,000 years." "In comparison with Niagara, it is safe to say that 150,000 to 200,000 years have passed since the lava plunged in a fiery flood into the gorge of the Canadian [River]." The descriptions of Crater Lake, Oregon, and the extinct snow-clad giants of the Cascade Range, set amongst their dense forests like a "belt of emerald studded . . . with immense brilliants," must be passed over, as well as the admirable accounts of the vast lava fields of the Columbia and the volcanoes of the Rocky Mountains, though they are full of good points.

A chapter is devoted to the noteworthy deposits of volcanic ash and dust, some of which locally attain a depth of fifty feet, and spread over such areas as 10,000 and even 53,000 square miles. These indicate that "disasters similar to those accompanying the eruptions of Conseguina and Krakatoa occurred at intervals throughout the Tertiary and Recent history of fully one-half of North America," leaving their traces in tracts of fertile soil and deposits of considerable economic value.

In his chapter on "Theoretical Considerations," Prof. Russell adopts the idea of "potential plasticity" of the earth's interior. From this he derives the pressure which brings molten matter to the surface, relegating to quite a secondary place the influence of steam. For many reasons he considers steam an accidental and non-essential constituent of lava, obtained by it when coming

into contact with water-saturated rocks. The association of volcanoes with ocean-margins he considers to be due to the fact that both classes of phenomena mark planes of weakness in the earth's crust. This chapter is well deserving of careful study, and the final one presents an interesting sketch of the chief events which mark the life-history of a volcano.

The book is carefully written, and well illustrated by maps and process-blocks from photographs. It would be a convenience if some simple mark had been used to indicate on the large map those volcanoes which have been active within recent times. W.

THE PRINCIPLE OF CONSERVATION OF ENERGY.

Das Princip der Erhaltung der Energie und seine Anwendung in der Naturlehre. Von Hans Januschke. Pp. x + 456. Medium 8vo. (Leipzig: B. G. Teubner, 1897.)

THOSE who are engaged in teaching applied mathematics cannot fail to appreciate the wide advantages arising from according greater prominence to the principle of conservation of energy than it obtained in the text-books of the last generation. Unfortunately, however, this principle, when stated in the restricted form in which it is most easily understood—viz. the mere assertion of constancy of the total energy, kinetic and potential, of a material system—is insufficient of itself to determine the actual motion of systems with more than one degree of freedom, and, moreover, cannot be applied to find the passive reactions arising from constraints. This particular point has been brought out forcibly in the recent controversy on "energetics" in which Boltzmann, Planck, Helm and others have taken part. Some further assumption or generalisation is necessary; either the principle of physical independence of force, or the extension of the principle of energy to virtual displacements (*i.e.* the principle of virtual work), or the hypothesis that the equation of energy holds good separately for every particle of a material system for the components of motion in every direction, or the assumption of the variational equation, or the principle of least action; all these alternatives are practically equivalent, and enable us to construct an energy theory of dynamics. Only quite recently Prof. Boltzmann, writing in *Wiedemann's Annalen*, suggested the possibility of building up the equations of motion, first of rigid bodies, and then of fluids and elastic solids, from the principle of energy aided by suitable subsidiary hypotheses; and the present volume is interesting as showing how this method works out when applied to a somewhat elementary text-book.

We fear that Herr Januschke hardly emphasises sufficiently the subtle difference between the restricted form of the principle and these necessary generalisations. At any rate, his deduction of d'Alembert's principle (p. 42) strongly reminds us of Clerk Maxwell's proof of the Lagrangian equations ("Electricity and Magnetism," vol. ii. § 561), the fallacy in which has been pointed out by Prof. J. J. Thomson. If we differentiate the equation of energy

$$W_0 + \Sigma(Fh + \tfrac{1}{2}mv^2) = \text{constant}$$

with respect to the only independent variable, the time t, where $dh/dt = v$, we obtain

$$\Sigma\left(F\frac{dh}{dt} + mv\frac{dv}{dt}\right) = 0,$$

whence, by taking account of the fact that (according to Herr Januschke) dh and dv are of opposite signs, it is possible to write down the equation

$$\Sigma\left(F - m\frac{dv}{dt}\right)dh = 0.$$

But here $dh = vdt$, and so the variations dh are not all independent, but their ratios are connected by relations of the form

$$\frac{dh_1}{v_1} = \frac{dh_2}{v_2} = \frac{dh_3}{v_3} = \ldots.$$

There is here no justification for the inference that such an equation will hold for variations other than such as are connected by this relation, *i.e.* for displacements other than those the body really undergoes. As regards the change of sign mentioned above, comment is superfluous.

In treating projectiles, the principle of independence of motions is assumed, and with this aid no difficulty occurs. But we naturally pass on to the treatment of "centrifugal force" as a more crucial test of the energy method, and here we find the result obtained either by a wholesale disregard of algebraic signs, or at any rate by what appears to an ordinary reader as such. Taking two particles m_1 and m_2 connected by a string of length r_1+r_2 and revolving in circles of radii r_1 and r_2, the kinetic energy is

$$W = \tfrac{1}{2}m_1v_1^2 + \tfrac{1}{2}m_2v_2^2.$$

For equilibrium the author writes down from this:

$$dW = m_1v_1dv_1 - m_2v_2dv_2 = 0$$

(why the sign of the second term should be changed is not obvious). Hence he infers that the tension in the string is

$$p = m_1v_1\frac{dv_1}{dr} = m_2v_2\frac{dv_2}{dr}.$$

Putting $v = rw$ where w is the angular velocity, he gets for the centrifugal force

$$p = \frac{m_1v_1^2}{r_1} = \frac{m_2v_2^2}{r_2}.$$

This result is obtained on the supposition of v being directly proportional to r. But in the theory of central orbits, it is known that unless work is done on the particle by tangential forces, the angular momentum, and not the angular velocity, is constant, and hence v ought to be taken inversely proportional to r, which would reverse the sign of the result. Hence Herr Januschke's method really makes the normal acceleration tend in the wrong direction.

After dealing with rigid bodies, the equilibrium and motion of fluids are considered; but this portion does not extend to the general equations of hydrodynamics (where we should have most liked to see how the "energetic" method works out), Torricelli's theorem and the hypothesis of parallel sections being alone considered. Gases follow next, then a chapter on "molecular forces" dealing with elasticity and capillarity. Chapter v. deals with heat, and includes a very fair exposition of the first and second laws of thermodynamics, the subject being opened

by a simple mechanical analogue, by means of which the conception of absolute temperature is introduced. The determination of specific heats, properties of gases, change of state, Van der Waals's equation, and the critical point are well treated, and an attempt is made to explain the phenomena from the molecular standpoint, so far as this can be done by general reasoning. The author's treatment of thermodynamics, however, does not present any striking divergence from the conventional standpoint in which conservation of energy necessarily occupies a prominent position. Of the chapters on electricity, magnetism and light, we can only say that they appear to form a concise and convenient introduction to the elementary principles of the subject.

As an introductory sketch of the outlines of natural philosophy, the book may be unhesitatingly recommended. The wide range of ground covered renders the treatment somewhat encyclopædic, but a notable feature is the large amount of historical information with which each chapter opens. This alone makes the volume valuable as a work of reference.

Another excellent feature is the large number of examples on nearly every section. Many of these are straightforward numerical calculations based on the bookwork, nearly all of them illustrate some point of physical interest. But it is a pity that the student after reading the question sees the answer before him, instead of having an opportunity to work it out for himself; these answers would be much better placed at the end of the book.

Whether Herr Januschke has succeeded or not in establishing the superiority of the "energetic" method, there can be no doubt that he has produced a text-book which will prove of great use to students, and still more to teachers of physics. G. H. BRYAN.

THE FERTILITY OF THE LAND.

The Fertility of the Land. By Isaac P. Roberts. Pp. xvii + 415. With forty-five illustrations. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THE sub-title of this volume, "A summary sketch of the relationship of farm-practice to the maintaining and increasing of the productivity of the soil," conveys a comprehensive idea of its scope. It belongs to the Rural Science Series, and Mr. L. H. Bailey, who contributes the preface, bestows upon the book a sort of editorial benediction when he commits himself to the statement, "It is the ripened judgment of the wisest farmer whom I have known." The editor further remarks,

"I confess that I have looked with some apprehension upon the rapid diffusion of experimental science of recent years, for there is danger that this knowledge may overshadow the importance of accustomed farm-practice, and lead the farmer to demand specific rules for each perplexity, and to depend upon the Experiment Station and the teacher for his farming."

The fifteen chapters deal with the following subjects: (1) an inventory of the land; (2) the evolution of the plough; (3) tilling the land; (4) conservation of moisture; (5) irrigation and drainage; (6) farm manures; (7) manures produced by various animals; (8) the waste of manures; (9) the care, preservation and application of manures; (10) nitrogen and nitrification; (11) the phosphoric acid and potash supply; (12) commercial fertilisers; (13) lime and various amendments; (14) green manures and fallows; (15) rotations. The treatment of the subject is thus seen to be fairly discursive, and the omission of, for example, the second chapter on the evolution of the plough would in no way have detracted from the main object of the volume. It may be noted in passing that the part of the implement which is familiarly known in this country as the skim coulter is designated the "jointer or skim plough" by the author; we think the English name is preferable as being more descriptive. Much valuable information is brought together in the volume in a convenient form, whilst most of the assertions made by the author, though they may not always carry conviction, are suggestive in character and calculated to stimulate useful trains of thought in the student's mind. The chief defect of the volume is that it ignores the epoch-making work in which Lawes and Gilbert have been engaged for more than half a century. Neither their names nor the name of Rothamsted are mentioned in the index, nor do we come across any reference to them in the text. As the author, we are told, "has had the advantage of much travel," we can only suppose this omission is intentional. The book, of course, suffers in consequence; to give only one instance, the author has missed entirely the admirable definitions of "fertility" and "condition" as applied by Lawes to the soil, and as usefully adopted for practical purposes by English farmers. That the writer is not altogether successful in his selection of authorities is further apparent from the circumstance that he betrays no knowledge of the researches of Warington in nitrification. There is evidence, however, of much familiarity with continental work, and the title of the thirteenth chapter, "lime and various *amendments*," has an unmistakably French flavour. The book is well printed and neatly turned out; but the Englishman who respects his mother-tongue will experience a shudder at the strange spectacle presented by certain familiar words spelt in "American."

CRIME AND CRIMINALS.

Crime and Criminals. By J. Sanderson Christison, M.D. Pp. 117. (Chicago: The W. T. Keenen Company, 1897.)

DR. CHRISTISON has been attracted to a subject full of difficult problems, but he makes no very practical contribution to their solution. He is a student in the school of Lombroso, and has been at some pains to investigate the psychological aspects of the criminal The cases he presents are, many of them, interesting enough; but beyond proving the fact that the types of offenders are much the same all the world over, they serve no particular purpose, and they are certainly not sufficient to justify the main point of his book—that our existing penal methods are a failure. He has been helped to this conclusion, moreover, by the single experience of the United States where, in his own words, "crimes are now nearly five times as numerous

as forty years ago." The criminal statistics of other countries, notably of England and Belgium, can happily show different figures, judging by the numbers incarcerated now and in previous years, the only trustworthy test indeed. Dr. Christison seems inclined to lay too much stress upon prison systems as affecting the increase and decrease of crime. Where they are manifestly bad, as it is to be feared they are in a very large proportion of cases in the United States, they may manufacture criminals. For example, there is no more fruitful source of crime than the indiscriminate association of prisoners of all classes and categories which is still very general in American prisons. For one Elmira, with its ultra-tenderness for the dishonest, there are hundreds of county gaols where no sort of care is taken to separate the inmates, whether young or old, innocent or guilty; and it is where this separation has been most strictly enforced, as with us, that crime has most appreciably diminished.

But the penal system, however carefully and intelligently worked, is but a small contributory cause to reduction. That is to be found rather in the newer and more enlightened processes of deferred sentences for first offenders and of systematic child rescue, both based upon the excellent principle that crime should be checked in the bud. Dr. Christison enunciates a truism when he declares that crime is frequently associated with bodily and brain disease. No one denies this; it is, too often the poor invertebrate creatures who have no sinew, moral or physical, who lapse into misdeeds, and they deserve pity rather than punishment. But these do not make up the sum total of the great army of crime; they do not include the stalwart, able-bodied habitual criminal—the real crux of modern penology—who has adopted law-breaking as a business, and whom nothing, humanely speaking, will cure. To apply Dr. Christison's kindly milk and water treatment to these would be a mischievous misuse of the power of the law, the first duty of which is to protect the law-abiding from the law-breaking. The habitual criminal should have neither truce nor peace. Penal science is fast tending to establish the somewhat paradoxical apothegm of a well-known writer who has said that offenders may be divided into two great classes: "those who should never go into prison and those who should never be let out"; the first offender who should be left at large on condition that he does not again go wrong, and the habitual criminal who is retained indefinitely, or until he gives reasonable promise that he will not persistently misuse his freedom.

OUR BOOK SHELF.

Chauncy Maples, D.D., F.R.G.S. A Sketch of his Life, with Selections from his Letters. By his Sister. Pp. 403. (London: Longmans, Green, and Co., 1897.)

THE publication of this memoir of Dr. Chauncy Maples—a pioneer missionary in East Central Africa for twenty years—reveals that sympathetic interest in science which has been strikingly noteworthy in some of the most remarkable missionaries of our time. In 1881 Mr. Maples, then stationed at Masasi, made a journey of 900 miles to the Meto country, and in this and other ways contributed to our knowledge of the geography of East Africa. His papers were appreciated by the Royal Geographical Society, of which he was a Fellow. And he quite entered into the spirit of the recent development of Nyasaland at the hands of the British administrators, founding and editing the *Nyasa News*, which was printed on the island of Likoma by his native boys. Sir Harry Johnston, K.C.M.G., contributed to it, and writes cordially of the late Bishop in his recent book on "British Central Africa." Sir Harry was almost the last European to see him alive; for a few days afterwards he was drowned in the Lake Nyasa, September 3, 1895, on his way to his post. In the Bishop's last letter but one, written, of course, before the knighthood, he says: "I was more struck than ever with the Commissioner's cleverness and accomplishments and his power of doing so many things, as he does, so very well. He is certainly a very remarkable man indeed."

On the other hand, Mr. G. F. Scott-Elliot, a scientific traveller well known to the readers of NATURE, looked upon Chauncy Maples as "an ideal missionary," and described him as "one whose sympathies extend even to Europeans." Several times in the letters now published reference is gratefully made to the geological works of Sir Archibald Geikie. In a private letter dated Likoma, March 14, 1888, Archdeacon Chauncy Maples has the following striking and sympathetic reference to Charles Darwin:—

"It would seem that part of his nature adapted to the reception and cultivation of religious truth got atrophied by disuse, and hence his discarding of Christianity. These things are great mysteries, and when we think of so great and really good a man as Darwin was, we ought to avoid all appearance even of seeming to know *how* he stood in God's sight when his probation was over and his soul returned to God who gave it. . . . Another great point about Darwin was that he never did or said anything that could be construed into a desire to disturb the faith of others; if evolution has disturbed it, it is their fault and not his. I confess to having a good deal of belief in evolution; but it has never disturbed my faith in revelation—no, not one jot" (p. 294).

The late Bishop was, like the friend and colleague who has succeeded him as Archdeacon, the Rev. W. P. Johnson, a graduate of University College, Oxford. His successor, the present Bishop of Likoma, Dr. J. E. Hine, is also an Oxford man, having graduated in science both in Oxford and London. Of the latter University he is M.D. It is also remarkable that another South African Bishop had a distinguished scientific career, both at London and Cambridge. The Bishop of Bloemfontein, the Right Rev. J. W. Hicks, is Doctor both of Medicine and of Theology. He is M.D. Lond., D.D. and Sc.D. Camb., and late Fellow and Science Tutor of Sidney Sussex College, Cambridge. J. F. H.

Les Ballons-Sondes. Par M. de Fonvielle. (Paris: Librairie Gauthier-Villars, 1898.)

WITHIN the last seven years a new epoch has dawned upon the science of aerial travel and investigation.

While the more directly practical advances in flying machines and balloon navigation have caught the popular fancy, a less conspicuous but more valuable means of extending our present knowledge of atmospheric physics has been supplied by the recently organised flight of small, specially constructed balloons provided with self-recording apparatus which, without the deterring weight of observers, have been able to explore regions of the atmosphere far beyond the limits of human endurance.

M. de Fonvielle, the celebrated French aeronaut, has brought together the results so far attained in a neat little brochure entitled "Les Ballons-Sondes," or "sounding balloons." Perhaps "exploring balloons" would be a freer and more euphonious translation.

Here we have in four chapters a clear and simple

account of these experiments from the earliest attempts of MM. Hermite and Besançon, the chief pioneers of the movement, to the latest ascents under the auspices of the International Committee in November 1896.

Perhaps the most interesting and suggestive chapter is that which deals with the theory of the ascent of an exploring balloon.

The results of the recent simultaneous international flight of aerophile balloons are also very suggestive.

The possible limits attainable by balloons are shown to depend quite as much on the character of the envelope as on the contained gas. Here also, for the first time, we find a clear exposition of the effect of the temperature of the gas over that of the surrounding air, and the "Montgolfier" effect of solar radiation in altering the height at which the balloon finds itself in neutral equilibrium.

When it is found that winter and summer can cause a change of 6000 feet, and day and night one of 8000 feet in the altitude attainable on the pressure theory, it must be recognised that the science of exploring balloons is far from simple.

The scientific value of such ascents, reaching as they have done already in the case of the "Cirrus" to 60,000 feet, or double that hitherto attained by man (Mr. Berson's 30,000 feet in the "Phœnix," December 1894), is undoubted, and M. de Fonvielle deserves the thanks of the scientific world for his lucid and fascinating account of a scientific art which is even more necessary for the advance of terrestrial and cosmical physics than the soundings of our deep-sea exploring ships. D. A.

A Geological Map of the Southern Transvaal. By F. H. Hatch, Ph.D., F.G.S. (London: Edward Stanford, 1897.)

THIS map, on the scale of four miles to the inch, will be useful to prospectors and those interested in the general geology of the district. The names and boundaries of the farms are given, and the geological map is accompanied by a physical map of the Transvaal.

The geological formations are broadly sketched in; the Witwatersrand, Black Reef and Megaliesberg series are represented as forming a trough let in by faults between a mass of primary rocks. The sections across country show a simplicity of structure for the Witwatersrand district with some complications by faulting north of Parys. The Witwatersrand beds are considered to represent the Table Mountain Sandstone and the Megaliesberg or Gats Rand series to be equivalent to the Zwartebergen Sandstone group.

The extent to which the beds are interfered with by volcanic rocks can be seen from the map. Besides the interbedded flows of basalts and diabases, a large area west of Klerksdorp is represented as composed of rhyolitic and andesitic flows, and north of the Megaliesberg Range and north-east of Pretoria there is a wide tract coloured as gabbro. The igneous flows of Pre-Karoo age are confined in Cape Colony to formations older than the Table Mountain Sandstone, so that if the age of the Gats Rand beds is correctly determined, the southern Transvaal exhibits a volcanic phase unrepresented in the Cape.

Untersuchungen über das Erfrieren der Pflanzen. By Prof. Dr. Hans Molisch. Pp. viii + 73. (Jena: Fischer, 1897.)

IN "Untersuchungen über das Erfrieren der Pflanzen," Prof. Molisch recounts his experiments on the cooling and freezing of plants. Dr. Molisch has worked over much of the old ground, and his observations, in the main, confirm those of previous workers. A comparison of the results obtained by Dr. Molisch with those set forth in the admirable summary in Pfeffer's "Pflanzen Physiologie," will show that the volume under notice contains little that is absolutely new.

By means of an improved apparatus, Dr. Molisch has examined the effects of freezing and thawing on such substances as starch-paste, gelatine, albumin and protoplasm. His conclusions confirm and extend those of Vogel and Kühne. As in the above-mentioned organic substances so in the protoplasm, *e.g.* of an amœba, freezing induces a reticular structure whose meshes contain pure ice. In many instances, however, ice formation only occurs, as is well known, outside the cell. Attention may, in passing, be drawn to the statement (p. 19) that, "to some extent," the smallness of plant cells represents "a means of protection against cold": were it not for the fact that the remark is considered worthy of repetition, it might have been regarded as intentionally ironical. As it is, it must be inferred that Dr. Molisch wishes to be numbered with the ultra-adaptationists.

Sachs had inferred, from observations on the relative rates of mortality in plants slowly and quickly thawed, that it is not the frost but the thaw that kills. H. Müller-Thurgau has shown this not to be generally correct. Dr. Molisch confirms H. Müller-Thurgau.

The most interesting of Dr. Molisch's experiments are those which prove that the withering of plants exposed to cold, although accompanied by, is not due to a slowing of the transpiration-current.

The practice of embodying a research in a volume intended for the public and the specialist alike is, where the results are of high generality, excellent; where, however, as in this volume, the results appeal primarily, if not solely, to the physiologist, and where the net is spread wide by rendering the meshes diffuse, fellow workers are entitled to protest. The "literature" is already a heavy burden and grievous to digest.

Random Shots at Birds and Men. By "Jim Crow." Pp. 117. (Westminster: The Roxburghe Press.)

THIS paper-covered booklet needs no extended notice from us. It is made up of very fugitive thoughts on birds, and moralisings on the ways of men, and is not, we should think, likely to interest either the student of science or the general reader.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Some Errata in Maxwell's Paper "On Faraday's Lines of Force."

IN translating this paper of Maxwell for Ostwald's "Klassiker der exacten Wissenschaften," I have detected some errors, which are partly merely misprints, but partly also faults in the formulæ of some trouble to the reader. The German translation is only of value to those who have not leisure to study the English language before the works of Maxwell; but the accuracy of such classic works is so essential to every one, that I considered the publication of the errata found to be of even greater importance than my whole translation. But in order to make the translation as cheap as possible, the German editor refused to print my list of errata, and I therefore hope it will be printed in England.

Finally, if Maxwell and the editor of his works have not avoided some troublesome errors, I do not wish to apply the *quod Jovi licet, non bovi licet*, to Mr. Curry's new book, "Theory of Electricity and Magnetism" (Macmillan, 1897), but to excuse some errors therein.

In the following table the first column gives the place of the misprint in the *Cambridge Philosophical Transactions*, vol. x. 1856; the second in Maxwell's "Scientific Papers," vol. i.

Cambridge Transactions	Scientific Papers	Read	Instead of
p. 38, l. 21 f. a.	p. 170, l 16, f. a.	external medium	internal medium
p. 39, l. 3 f. b.	corrected	$S_1\beta + (m\alpha - l\beta)T$	$S_1\beta - (m\alpha - l\beta)T$
p. 40, l. 6 f. a.	,,	$\beta = \frac{dp}{dy}$, $\gamma = \frac{dp}{dz}$	$y = \frac{dp}{dy}$, $z = \frac{dp}{dz}$
p. 42, l. 1 f. b.	,,	$X = -\frac{dp}{dx}$	$X = -\frac{pd}{dx}$
p. 54, l. 12 f. b.	p. 192, l. 2 f. a.	$-4\pi\rho$	$+4\pi\rho$
,, ,, 11 ,,	,, ,, 3 ,,	$-\int ed\mathrm{S}$	$+\int ed\mathrm{S}$
p. 56, l. 16 f. a.	corrected	$\beta_1 + \frac{d\beta_1}{dz}\frac{dz}{2}$	$B_1 + \frac{d\beta_1}{dz}\frac{dz}{2}$
,, ,, 2 f. b.	p. 195, l. 2 & 3 f. a.	$\alpha_1, \beta_1, \gamma_1$	$\alpha\beta\gamma$
p. 58, l. 10 f. b.	corrected	$\frac{1}{k}$	k
p. 59, l. 5 f. b.	p. 198, l. 4 f. b.	$\int\frac{da}{dz}dz$	$\int\frac{da}{dy}dz$
p. 62, l. 2 f. a.	p. 201, l. 13 f. a.	$4\pi\rho_1 + (a_0a_2 + b_0b_2 + c_0c_2)$	$4\pi\rho_1 - (a_0a_2 + b_0b_2 + c_0c_2)$
,, ,, 14 f. b.	p. 202, l. 5 ,,	$-\alpha_0\left(\frac{d\beta_1}{dz} - \frac{d\gamma_1}{dy}\right) - \beta_0\left(\frac{d\gamma_1}{dx} - \frac{da_1}{dz}\right) - \gamma_0\left(\frac{da_1}{dy} - \frac{d\beta_1}{dx}\right)$	$+\alpha_0\left(\frac{d\beta_1}{dz} - \frac{d\gamma_1}{dy}\right) + \beta_0\left(\frac{d\gamma_1}{dx} - \frac{da_1}{dz}\right) + \gamma_0\left(\frac{da_1}{dy} - \frac{d\beta_1}{dx}\right)$
,, ,, 13 ,,	,, ,, 7 ,,	$\rho_1') +$	$\rho') -$
,, ,, 11 ,,	,, ,, 9 & 11 f. a.	ρ'_1 and ρ_1	ρ' and ρ
,, ,, 9 ,,	corrected	$+ (a_0a_2 + \beta_0b_2 + \gamma_0c_2)$	$- (a_0a_2 + \beta_0b_2 = \gamma_0c_2)$
p. 63, l. 9 f. b.	p. 203, l. 11 f. b.	$\rho_1\rho_1 +$	$\rho_1\rho_1 -$
p. 64, l. 13 f. a.	p. 204, l. 15 f. a.	$dxdydz = 0$	$dxdydz$
,, ,, 15 ,,	,, ,, 18 ,,	$+\frac{1}{4\pi}\frac{d}{dt}\left(a_2\alpha_0 + b_2\beta_0 + c_2\gamma_0\right) = 0$	$= \frac{1}{4\pi}\frac{d}{dt}\left(a_2\alpha_0 + b_2\beta_0 = c_2\gamma_0\right)$
,, ,, 3 f. b.	corrected	particle	article
p. 69, l. 9 f. b.	p. 211, l. 10 f. b.	b_1	b
,, ,, 1 ,,	corrected	$\frac{a}{R}$	$\frac{a}{R}$
p. 70, l. 12 ,,	p. 212, l. 4 f. b.	$\rho\frac{d}{dx}\left(\frac{m}{r}\right)$	$\frac{d}{dx}\left(\frac{m}{r}\right)$
p. 71, l. 3 ,,	corrected	α, β, γ	$\alpha_1, \beta_1, \gamma_1$
p. 72, l. 11 f. a.	p. 214, l. 4 f. b.	x	X
,, ,, 12 ,,	corrected	α	α_1
,, ,, 12 ,,	p. 214, l. 2 f. b.	$-\alpha + \frac{d\alpha}{dz}\frac{l_3}{2}$	$-\alpha + \frac{d\alpha}{dz}\frac{l_2}{2}$
p. 73, l. 14 ,,	p. 216, l. 6 f. a.	$+2\frac{k - k^1}{2k + k^1}\frac{a^3}{r^3}\left(1 - 3\cos^2\theta\right)$	$+\frac{k - k^1}{2k + k^1}\frac{a^3}{r^3}\left(1 - 3\cos^2\theta\right)$
,, ,, 18 ,,	,, ,, 11 ,,	$\left(2 - \frac{k - k^1}{2k + k^1}\frac{a_2}{b_3}\right)$	$\left(1 - \frac{k - k^1}{2k - k^1}\frac{a^3}{b^3}\right)$
p. 75, l. 4 f. a.	p. 218, l. 12 ,,	y and z	x and y
p. 76, l. 10 f. b.	p. 220, l. 13 ,,	k is Aa^3	$k = Aa^3$
,, ,, 8 ,,	,, ,, 14 ,,	$p' = -\left(1 + A\right)\frac{a^3}{r^3}\cos\theta$	$p' = \left(1 + A\right)\frac{a^3}{r^3}\cos\theta$
,, ,, 8 ,,	,, ,, 14 ,,	$p_1 = -(1 + A)r\cos\theta$	$p_1 = (1 + A)r\cos\theta$
,, ,, 5 ,,	corrected	$\frac{2}{k^1}\left(1 + A\right)$	$\frac{2}{k}\left(1 + A\right)$
p. 77, l. 15 f. a.	p. 221, l. 10 f. a.	at $d\theta$	$td\theta$
,, ,, 17 ,,	,, ,, 12 ,,	$\frac{3I}{t}\sin\theta$	$-3I\frac{a}{t}\sin\theta$
p. 78, l. 12 f. b.	corrected	$\frac{d\beta_0}{dz}$	$\frac{d\beta_0}{dr}$
,, ,, 10 ,,	p. 223, l. 8 f. a.		
,, ,, 7 ,,	,, ,, 11 ,,	$\frac{1}{2k + k^1}$	$\frac{1}{3k + k^1}$
p. 79, l. 6 f. a.	,, ,, 2 f. b.		
,, ,, 14 ,,	p. 224, l. 8 f. a.		
,, ,, 6 ,,	p. 223, l. 2 f. b.	I_2	I
,, ,, 3 ,,	corrected	n'	n

Cambridge Transactions	Scientific Papers	Read	Instead of
p. 79, l. 6 f. b.	p. 224, l. 6 f. b.	$\frac{Nn'^2}{RR'}\frac{dF}{dt}$	$N\frac{n'^2}{R'}\frac{dF}{dt}$
p. 81, l. 11 ,,	p. 226, l. 1 ,,	$\nabla^2 f_2$	$\nabla^2 f$
,, ,, 2 ,,	corrected	$-\frac{1}{4\pi}\frac{I}{2}\cos\theta\omega y$	$\frac{1}{4\pi}\frac{I}{2}\cos\theta\omega y$
p. 82, l. 4 f. a.	,, ,,	$k\left(\frac{da_2}{dy}-\frac{db_2}{dx}\right)$	$k\left(\frac{dv_2}{dy}-\frac{dv_2}{dx}\right)$
,, ,, 9 ,,	,, ,,	$f_2=\frac{I\omega}{16\pi}\left[-\left(x^2+y^2\right)\cos\theta+xz\sin\theta\right]$	$f_2=\frac{I\omega}{16\pi}\left[\left(x^2+y^2\right)\cos\theta-xz\sin\theta\right]$
,, ,, 14 ,,	p. 228, l. 6 f. a.	$\frac{TR^4}{48\pi k}\omega I\sin\theta$	$\frac{TR^3}{48\pi k}\omega I\sin\theta$
,, ,, 9 ,,	,, ,, 14 f. b.		
,, ,, 7 ,,	,, ,, 12 ,,		
,, ,, 3 ,,	,, ,, 7 ,,	I	I_1
p. 83, l. 3 ,,	,, ,, 2 ,,		
p. 82, l. 3 f. b.	,, ,, 7 ,,		
,, ,, 2 ,,	,, ,, 6 ,,		
p. 83, l. 3 f. a.	,, ,, 2 ,,	TR	T
,, ,, 4 ,,	,, ,, 1 ,,		
,, ,, 12 ,,	p. 229, 8 f. a.		
,, ,, 6 ,,	,, ,, 1 ,,	$\operatorname{cotg}\phi=-\frac{TR\omega}{24\pi k}$	$\operatorname{cotg}\phi=-\frac{TR^3\omega}{24\pi k}$
,, ,, 6 ,,	,, ,, 1 ,,	$I'=\frac{1}{2}\frac{\frac{TR\omega}{24\pi k}}{\sqrt{1+\left(\frac{TR\omega}{24\pi k}\right)^2}}I\sin\theta$	$I'=\frac{1}{2}\frac{\frac{T}{24\pi k}\omega}{\left(\sqrt{1+\frac{T}{24\pi k}\omega}\right)^2}I_1\sin\theta$
,, ,, 7 f. b.	,, ,, 9 f. b.	$\frac{T\omega R^3 I\cos\theta}{\frac{1}{2}\sqrt{(24\pi k)^2+T^2R^2\omega^2}}$	$\frac{T\omega R^3 I\cos\theta}{\frac{1}{2}\sqrt{(24\pi k)^2+T^2u^2}}$
,, ,, 5 ,,	,, ,, 6 ,,	$\frac{12\pi k T\omega R^4 I^2\cos^2\theta}{(24\pi k)^2+T^2R^2\omega^2}$	$\frac{12\pi k T\omega R^3 I^2\cos^2\theta}{(24\omega k)^2+T^2\omega^2}$
,, ,, 3 ,,	,, ,, 4 ,,	$\frac{12\pi k T\omega^2 R^4 I^2\cos^2\theta}{(24\pi k)^2+T^2R^2\omega^2}$	$\frac{12\pi k T\omega^2 R^3 I^2\cos^2\theta}{24\pi k+T^2\omega^2}$

Vienna, October 25. LUDWIG BOLTZMANN.

The Late Dr. Haughton.

IN your account of the late Dr. Haughton, as well as in those written of him elsewhere, I see no mention of a somewhat fantastic instance of his versatility—namely, his investigation into the most merciful way of hanging criminals. It was, I believe, entirely owing to him that the present method of the "long drop" was introduced. According to the older method the rope was so arranged that the culprit fell barely knee deep, all the rest of his body being in view above the scaffold. He died usually by strangulation, sometimes combined with apoplexy, after what seemed to be a protracted agony Now, he is allowed to fall through some 10 feet, more or less, according to his estimated bulk and weight, and he dies with a broken neck more painlessly than virtuous persons in their own beds. The problem was to find out the length of drop that would suffice to break the neck bone, but would be insufficient to tear off the head. Dr. Haughton experimented on the tensile strengths of the spine and of the muscles, and he published a formula for the length of drop, dependent on the height and weight of the culprit. In this, I thought he had omitted a small factor, and wrote to him about it—namely, the increased sectional area the muscles of the neck in fat men. It should be mentioned that a case actually occurred in which the drop was too deep, and the head of the criminal became wholly detached, and the legal doubt arose whether under those circumstances the sentence of being "hanged by the neck" had been duly carried out. I regret much that I have to write wholly from memory now, which I trust has not deceived me. It is very possible that Dr. Haughton's formula may be found in one of the earlier numbers of NATURE. F. G.

The Supposed Dowsing Faculty.

PERMIT me to guard your readers against a misapprehension likely to be caused by the review in NATURE of October 14, of an investigation I have recently published on the alleged existence of a faculty for finding underground water, a power claimed by certain persons called "diviners" or "dowsers."

The reviewer states twice over that the "bulk of the paper is taken up with hearsay evidence," and again that it is "an accumulation of second-hand evidence," and that I do not give "enough weight to the natural tendency of mankind to conceal their failures." If these statements could be justified I should agree with your reviewer that my investigation "leaves the subject in the same state as it found it." But the peculiar meaning your reviewer attaches to the words he employs, and hence the value of his opinion, may be inferred from the following facts:—

Six years ago I was asked by the Council of the Society for Psychical Research to examine this question. I had, therefore, in addition to experiments which I myself conducted, to take the place of a judge in a court of inquiry, and give weight to no evidence but that of *eye-witnesses;* and so, in almost every one of the 152 numbered cases *pro* and *con* that are given in my paper, I quote such written and signed evidence, independent of the dowser himself. These witnesses are mostly men of good position, or wide experience, and to whom the question of obtaining water was a matter of practical importance and pecuniary outlay. The argument that some of them were biassed is a perfectly fair criticism, if true, but the bias was usually more on the side of incredulity than of credulity; take, *e.g.* the extreme scepticism of Mr. Richardson, the employer in the remarkable Waterford case, and of Sir Henry Harben in that at Warnham.[1] No evidential value is

[1] It may well be urged that a man would not employ a dowser unless he were already biassed in his favour. But the gentlemen named above, and several other witnesses I have cited, consented to this course, either to gratify their friends, or as a *dernier ressort*, only after scientific advice and large expenditure on boring had failed to find the water supply they needed. Their attitude towards the dowser when he arrived was that of ill-disguised contempt. How far "lucky hits" or "mother wit" can explain the dowser's success in these and other cases, the reader of my paper must judge for himself.

attached in my paper to any case not fully corroborated, and out of scores of such cases received some half-dozen have been published, as is expressly stated in my paper, in order to elicit further information on account of their intrinsic interest.

As regards the liability to overlook failures, I have referred to this point both at the outset of my paper (p. 4) and elsewhere; further (on pp. 238 and 239), I state: "It must be borne in mind that (especially among amateur dowsers) one is more likely to hear of success than failure, and therefore an extensive and searching inquiry is necessary before any safe induction can be drawn. . . . All that was possible in the present investigation was to make the range of evidence as wide and unbiassed as possible, and not exclude a single case of failure that was substantiated. This has been done." It is, of course, easy to select, as your reviewer does, a certain number of cases in which the failures exceed the successes.[1] But I think one is more likely to arrive at a correct estimate by the method I adopted, which was to make extensive inquiries, both generally and specifically, with regard to failures as well as successes in the case of every professional dowser I heard of. This is naturally a vastly more laborious method than your reviewer's, but was necessary in order to arrive at the actual facts in a subject which from all sides has been loosely discussed, albeit by eminent men, for upwards of 200 years.

I am glad to find your reviewer endorses certain cautions I suggested in the event of further investigation; though what he means by "thought-reading" as a source of error is not quite clear. It is a matter of importance, more so than your reviewer appears to imagine, to recognise, and if possible exclude, the aid which the dowser derives from indications given by the surface of the ground. Long practice may give the most illiterate person a power of detecting surface indications of underground water, or the faint tremor of unseen running water, that would entirely escape the ordinary observer, and of enabling correct inferences to be drawn even from indications that the dowser may have noticed quite unconsciously. We have here, doubtless, the explanation of some of the singular successes of dowsers in finding water; but a careful examination of the evidence I have collected has led me to think that no explanation hitherto suggested is adequate to account for all the facts.[2]

Kingstown, Co. Dublin, October 21. W. F. BARRETT.

AT the head of Prof. Barrett's memoir is the following quotation from Mr. Andrew Lang: "There are two ways of investigating the facts or fancies about the divining rod. One is to examine it in its actual operation—a task of considerable labour, which will doubtless be undertaken by the Society for Psychical Research; the other, and easier way, is to study the appearances of the divining wand in history." This naturally led me to think that Prof. Barrett intended to treat the subject as, in the main, a matter for personal investigation. He now claims, however, "to take the place of a judge in a court of inquiry." I therefore withdraw the term "hearsay" applied to the bulk of the evidence he has so laboriously collected, and will accept his own view of his position.

But Prof. Barrett will agree with me that this is a technical investigation needing expert knowledge. Now if so, where does the necessity for expert knowledge come in? Surely not after the experiments have all been made, and the dowser is off the scene; but, as in any other scientific investigation, on the spot, with the man and the conditions all before you. This is the very core of the investigation, and no amount of after analysis can atone for the lack of *personal* observation and judgment exercised at this, the crucial point. But here, where expert knowledge and observation are essential, he relies on others, of whom the majority have no previous knowledge or scientific training whatever.

Prof. Barrett "had to exclude all evidence but that of *eye-witnesses*." As to his "152 numbered cases," 9 are avowedly supplied by people who, on their own statement, do *not* appear to be eye-witnesses. In 41 more there is nothing to show whether his informant met the dowser himself, or is trusting to information received from others. The information in 8 of these comes from a firm or joint-stock company; 8 are merely newspaper reports; some are ancient cases, which cannot now be inquired into.

With reference to the statement regarding liability to overlook failures, I did not state or wish to imply that Prof. Barrett had not fairly given all the failures which came to his knowledge. What I did wish to imply was, that his method of writing to the parties concerned for evidence on this point was not likely to yield much result.

As to the Isle of Wight, I may say, that not making it a habit to collect information regarding the employment of dowsers in different districts, I merely alluded to one where I happened to have stumbled upon facts bearing on the question. Whether or no other districts would give similar or contrary results I cannot say, having no material to go upon.

I fail to understand what meaning Prof. Barrett attaches to the term "surface indications." He agrees with me as to their great importance; yet there are only 32 cases in which his informants make even the slightest reference to this subject, and in only 8 is there any note that Prof. Barrett made special inquiries on this all-important point.

As previously stated, my criticisms apply to the bulk of the evidence. I thoroughly recognise the value of Prof. Barrett's personal observations, and have only to regret that these experiments form so very small a part of his memoir.

THE WRITER OF THE ARTICLE.

[1] The reviewer is, however, delightfully free from the pedantry of those who think accuracy desirable when dealing with such a contemptible superstition as the so-called divining-rod. This, I think, is apparent already; it becomes more so when specific assertions of his are examined, such *e.g.* as "only two successes are mentioned in the Isle of Wight," &c.

[2] That a mixture of crass ignorance and charlatanry is to be found in many professional dowsers, and that some of them are little better than rogues, is only what might be expected; but, on the other hand, we have the fact that so distinguished a *savant* as M. Mortillet was once, as he tells us himself, a professional dowser, and published a book on water-finding in 1849. The President of the Royal Geological Society of Cornwall is still a successful amateur dowser.

A Proposed Memorial to Prof. Victor Meyer.

THERE appears to be a strong desire among many of the British students who worked under the late Prof. Victor Meyer, to give expression to the feelings of gratitude and admiration with which they remember him, by raising some form of memorial to be placed in the Heidelberg Lecture Theatre.

It has therefore been decided to call a general meeting of Prof. Meyer's British students, to be held in Manchester on Saturday, December 11, at 5 p.m. Prof. H. B. Dixon, F.R.S., has kindly placed the Organic Lecture Theatre of Owens College at our disposal.

All past students of the late Victor Meyer, whether they worked with him in Zürich, Göttingen or Heidelberg, are earnestly requested to be present.

I shall be pleased to receive suggestions from any who may be unable to attend, in order that they may be laid before the meeting. J. J. SUDBOROUGH.

University College, Nottingham, November 23.

The Critical Temperature of Water.

CAN any of your readers tell me what is the critical temperature of water. I find in the supplement to Jamin and Bouty's "Cours de Physique" the critical temperature given as 370° C. and the corresponding pressure as 195·5 atmospheres. On the other hand, Cagniard-Latour gave this temperature as equal to the melting point of zinc, which is known to be about 415° C.

I have some theoretical grounds for believing this latter figure to be the more accurate, so should be glad to know what other determinations, if any, have been made. H. M. MARTIN.

39 Guildford Street, W.C., November 19.

Coccoliths in our Coastal Waters.

IN our communication to NATURE, September 16, 1897, we say "the presence of these bodies (coccoliths) in our coastal waters does not appear to have been recorded." Since this was written we find that Dr. Wallich, in the *Ann. and Mag. of Natural Hist.*, vol. ii. 1868. p. 319, stated "Coccospheres have been met with by me profusely . . . in material collected at the surface of the open seas of the tropics, and also in dredgings from shoal water off the south coast of England."

November 18. J. JOLY.
HENRY H. DIXON.

Phenomena Exhibited by Jackson Tubes.

WHILE investigating the best methods of working the ordinary form of Jackson tubes during the last fourteen months, I have noted the following interesting phenomena.

Four tubes developed a phosphorescent ring or halo rotating rapidly round the anode, which by carefully heating became comparatively steady; this I ventured to name the Saturn condition.

Four tubes developed in bulb broad bands of light yellow-green electrical molecules, interspaced with darker bands; this was like the marking of the planet Jupiter.

Two tubes developed a mottled and leaf-patterned electric-molecular condition, extremely like the appearance of the photosphere of the sun (for the first time the skin of my hand was affected by one of these tubes—November 1896; this hand having some years previously had gouty eczema; the other hand was not affected in either case).

Two tubes developed forms like the clouds known as "mares'-tails"; one tube, a form like the sulky lower strata of distant thander-clouds.

The most interesting phenomenon was one which was also seen by a medical friend: the whole tube was a mass of yellow-green phosphorescence, even behind the kathode; the molecular film in glass bulb in front and round the edge of the kathode (mottled condition) developed a small black spot the size of a pin-head, which increased to the dimensions of a small pea, broadened out into an irregular patch, split up into small spots, which ran round the bulb, disappeared; reformed into a patch—diminished—and disappeared. The phenomenon was repeated at regular intervals for ten minutes, then finally stopped. The irregular patch was extremely like a sun-spot.

From time to time I have called the attention of interested friends to the above phenomena, so as to have witnesses, as the tubes seldom repeat the same conditions, which can only be attained by the application of heat while working the tube.

The rays magnetised my watch on two occasions; an induction coil having no magnetic field, owing to interrupted current, could not do this. WILLIAM WEBSTER.

Art Club, Blackheath.

REMARKABLE TERMITE MOUNDS OF AUSTRALIA.

THE destructive propensities and architectural endowments of the termites or white ants are familiar subjects to most travellers and residents in tropical countries. Notwithstanding, however, the almost cosmopolitan distribution within tropic areas of these insect pests, an astonishingly small amount of accurate data has been chronicled concerning their specific varieties or the widely varying modifications of their social tenements.

As a matter of fact the figures and descriptions of the insects and nest mounds or "termitaria" of the African white ants *Termes bellicosus*, *T. mordax*, and other species contributed by Henry Smeathman to the *Transactions* of the Royal Society for the year 1781, constitute up to the present date the standard account of white ants and their ways that is reproduced with trivial variations in most modern zoological text-books. Much, undoubtedly, has been accomplished within recent years, notably through the investigations of Grassi and Sandias, Fitz Müller, and other biologists to elucidate the minute anatomy, individual modifications, and social economy and relationships of the indigenous or imported South European types *Termes incifugus* and *T. flavipes*. Neither of these forms, however, are mound constructors, but live within subterranean tunnels or in excavations of the wood which they devour. Smeathman is hence still left, *facile princeps*, the first, almost the only authority on the architectural fabrications of the mound-constructing species.

While Africa in connection with Smeathman's investigations has hitherto inherited an undisputed monopoly in the matter of termite mounds, it will probably be found that the island continent of Australia can produce an equally, and in some respects even more noteworthy variety of these insect edifices. So far as altitude is concerned, the palm among the Australian series must be conceded to the huge buttressed columnar termitaria that occur some forty miles inland from Port Darwin in the Northern Territory of South Australia. A height of at least eighteen feet is not unfrequently attained by this variety, and their diameter being almost equal throughout, their appearance has been appropriately likened to miniature towers. Termitaria almost equal in altitude to this Port Darwin variety have also been observed by the writer in York Peninsula, North Queensland, and are notably abundant on the point of land abutting upon the mainland foreshore of the southern entrance to the Albany Pass. The largest termitaria of this type occur, however, in the vicinity of the bridle path between Mr. Frank Jardine's homestead at Somerset, and the former telegraph station at Patterson facing Endeavour Strait. Passing them on horseback, many of these mounds were observed to tower considerably above the rider's head. The contour of these York Peninsula termitaria differs essentially from that of the Port Darwin form. In place of being subcylindrical or columnar, they are distinctly pyramidal, widest at the base, and tapering up to a single, or it may be occasionally several accuminate points.

Within the tropical area of Western Australia, known as the Kimberley district of that colony, a third large and very distinct type of termitarium is dominant. While most commonly presenting a symmetrically conical or hemispherical contour, it not unfrequently happens that these white ant mounds are built up into the most irregular and fantastic shapes. Throughout all such innumerable modifications, however, one essentially unique fundamental plan of structure is predominant. This is exemplified by the circumstance that each nest mound or termitarium presents the appearance of having been built up, as it were, by the superposition of consecutive hod-loads of half solidified mortar, and which before setting has partly overflown and overlapped the preceding instalments.

This lobulated or Kimberley type of termite mound, as it may be designated, occurs in great abundance and in its finest development in the thinly wooded scrub or so-called "pindan" in the neighbourhood of Derby, at the head of King's Sound. One of the tallest of these termitaria was found to measure as much as fourteen feet, but this altitude is occasionally exceeded. The separate occasions on which the writer visited King's Sound were utilised by him for obtaining information concerning the approximate time that is occupied by the termites in the reconstruction of a partially dismantled edifice. Examples of termitaria about eight feet high were bisected vertically, the one half being completely demolished. Within twelve months one quarter of the denuded area had been filled in. Visited eighteen months later, fully two-thirds of the demolished moiety had been rebuilt, and it would evidently have not taken more than another twelve-months, or a total of between three or four years, to restore the mound to its original symmetrical shape and dimensions.

The most remarkable, though by no means the most lofty of the termite edifices peculiar to Australia, are those modifications of these structures which are popularly known by the local titles of "meridian," "magnetic," or "compass" ants' nests. The termitaria belonging to this category are distinguished by their elongate, much compressed contour, comparable in the most evenly constructed examples to huge slabs of undressed sandstone set up on edge. The upper edge or ridge of the "Meridian" termitarium is always the narrower, and is either nearly smooth, irregularly serrated, or may be developed into a series of slender pinnacles. The most notable feature respecting these white ant mounds is, however, the circumstance that the orientation of their longer axis is always coincident with the local parallel of latitude, or, in other words, in a precise line with the north and south points of the magnetic compass.

The most striking examples of these meridian ants' nests observed by the writer occur in the Laura Valley, North Queensland, some sixty miles from Cooktown. The altitude of these Laura Valley ant mounds is not very considerable, rarely, indeed, exceeding six or eight

feet. In accord with the peat-like alluvium out of which they are excavated and constructed, their colour is a dark ashen grey or nearly black. A distinctive feature of these meridian ants' nests is their highly ornate architectural style. They consist of a congeries of slender pinnacles erected close to one another in the same straight line, and which are finally amalgamated. Upon these primary pinnacles numerous subsidiary ones are usually constructed. The completed edifice, with its full complement of spires and pinnacles, comes thus when viewed end on, as shown in certain of the photographs taken, to present in miniature a by no means remote resemblance to the architectural pile of some grand cathedral.

A second and simpler form of meridian ants' nest is especially abundant a few miles inland from Port Darwin. It differs from the preceding type in its more massive and less ornate structural plan. The upper edge is nearly smooth or irregularly serrated, but not produced into a series of slender pinnacles. It is further noteworthy, that the environments pertaining to these two meridian varieties differ materially. With the Port Darwin type the habitat affected is that of open grassy plains, while in the Laura Valley form the nest mounds are most abundantly constructed in typical, though thinly wooded forest land.

The *raison d'être* of the north and south directions of the longer axial planes, so eminently characteristic of the so-called "Meridian" ants' nests, has given rise to much speculation and a variety of interpretations. By some it is supposed to bear a direct relationship to the prevailing winds. As, however, those in the districts where these ant-hills occur are chiefly south-east or north-west, according to the seasonal monsoon, that interpretation cannot be accepted as satisfactory. To the writer's mind a more probable explanation would appear to present itself in connection with the circumstance that being constructed in this precise meridian line, their larger surface presents the least possibly prolonged exposure to the meridianal rays of the tropical sun, and that the structures are consequently so built that they shall absorb and retain a minimum amount of solar heat. This question is, however, an interesting one that undoubtedly invites further scientific investigation. The subject of Australian termitaria constitutes, it may be noted, a copiously illustrated chapter in the writer's recently published work, "The Naturalist in Australia."

W. SAVILLE-KENT.

THE LIQUEFACTION OF FLUORINE.

FLUORINE was prepared for the first time in 1886 by Prof. Moissan, as a product of the electrolysis of anhydrous hydrogen fluoride contained in a platinum apparatus provided with fluorspar stoppers; the new gas was at once found to be the most active chemical substance known, many elements and organic compounds, such as arsenic, antimony, sulphur, iodine, alcohol, and turpentine, immediately and spontaneously bursting into flame when plunged into an atmosphere of fluorine. On mixing the gas with hydrogen, even in the dark, a violent detonation immediately occurs, hydrogen fluoride being produced. The violent action of fluorine upon nearly all substances with which it is brought into contact, obviously renders extremely difficult all experimental work involving the use of the free element. The great manipulative difficulties necessarily arising whilst dealing with the gas on the large scale have, however, been very happily surmounted by Prof. Moissan and Prof. Dewar, who recently described to the Chemical Society the method by which they have succeeded in liquefying fluorine, and determining the more important properties of the liquid substance (*Proc. Chem. Soc.*, November 4, 1897, p. 175). It seemed likely that the great chemical activity of fluorine might so far decrease at low temperatures as to allow of the manipulation of the material in a glass vessel cooled in liquid air; this was found to be the case.

The fluorine required in the work was prepared by the electrolysis of anhydrous hydrogen fluoride; this liquid being a non-conductor, was made a conductor by dissolving in it potassium fluoride. The liberated fluorine was freed from hydrogen fluoride by being passed first through a platinum worm immersed in a cooling mixture of solid carbon dioxide and alcohol, and subsequently through platinum tubes containing dry sodium fluoride. The purified gas was then passed down a vertical platinum tube fused to the neck of a thin glass bulb which served as the collector, and an exit was provided through a narrower platinum tube contained inside the first. On cooling the apparatus down to $-183°$ in boiling oxygen whilst the fluorine is passing through, no liquefaction occurs, but on reducing the pressure under which the oxygen is boiling, and so lowering the temperature to $-185°$, the fluorine condenses in the glass bulb to a very mobile yellow liquid; on removing the bulb from the cooling bath the liquid fluorine boils vigorously. Other experiments made with boiling liquid oxygen and liquid air as refrigerating agents indicated that fluorine boils at about $-187°$, namely at the boiling point of liquid argon; from this the probable critical temperature and pressure of fluorine are deduced as $-120°$ and 40 atmospheres respectively.

At these low temperatures fluorine is without action on glass, and does not displace iodine from iodides; silicon, boron, carbon, sulphur, phosphorus and reduced iron, all of which spontaneously ignite when brought into contact with fluorine at ordinary temperatures, do not inflame if, after being cooled in liquid oxygen, they are plunged into an atmosphere of fluorine. Hydrogen gas inflames spontaneously, with considerable evolution of light and heat, when directed on to the surface of liquid fluorine at $-190°$; on passing fluorine on to solidified turpentine cooled by boiling liquid air, a series of explosions occurred resulting in the destruction of the apparatus. It thus seems that the great affinity existing between hydrogen and fluorine is not overcome at $-190°$. A little liquid fluorine falling on the floor instantly inflames the wood. Fluorine is soluble in liquid oxygen, and on passing in the gas a white flocculent precipitate is formed which, after filtering off, deflagrates violently as the temperature rises; it is possibly a hydrate of fluorine.

Determinations made by floating pieces of various substances in liquid fluorine indicate that its density is about 1·14, and from the invisibility of amber immersed in the liquid the refractive index of the latter would seem to be higher than that of liquid air or oxygen. Liquid fluorine shows no magnetic phenomena when placed between the poles of a powerful electromagnet; it has a smaller capillarity constant than liquid oxygen, and does not solidify at $-210°$. It has no absorption spectrum, and its colour is the same as that of the gaseous element.

W. J. P.

THE LEONID DISPLAY, 1897.

VERY unfavourable weather appears to have prevented the successful observation of the Leonids at their recent return. In consequence of this the impression seems to have gained ground that the phenomenon did not occur as predicted. This is, however, a mistake. Could those observers who saw so little on the night of the 13th, have viewed the sky late on the following night, they must have been satisfied at the character of the display. Between about 4.30 and 6 a.m. on Monday morning the 15th, the usual streak-leaving meteors from Leo became very numerous, and some of them were unusually brilliant, one, which

appeared at 5.25 a.m., being brighter than the moon. Unfortunately the sky was overcast at the great majority of places at the time when the maximum occurred, and very few reports have come to hand, but they furnish unquestionable evidence as to a plentiful fall of meteors in the few hours preceding sunrise on the 15th.

Before midnight on the 13th, and during the early morning hours of the 14th, meteors were comparatively rare, and may be said to have been more conspicuous by their absence than by their presence. The shower of Leonids was of an extremely meagre character, and such as might occur in an ordinary year with the parent comet near its aphelion. But, apart from the disappointing meteors, the night of the 13th was one of singular beauty. At Bristol the sky partly cleared at 11.30 p.m., and the atmosphere became remarkably transparent. The moon and stars shone very brightly, and films of white cloud, floating rapidly across the sky, gave it a very picturesque appearance.

From the observations reported it may be well to make a few extracts :—

Mr. S. H. R. Salmon, South Croydon.—Sky perfectly clear November 13, 14h. to 16h. About seven meteors seen, including four bright ones as under :

h.	m.	s.	
15	3	45	First mag. from Andromeda.
15	28	0	First mag. Leonid.
15	32	45	First mag. Not a Leonid.
15	53	0	= Sirius. Probably a Leonid. It fell in a curved path slightly south of Jupiter, and was a beautiful object.

Rev. S. J. Johnson, Bridport.—Tolerably clear on November 13, between 15h. and 15h. 30m., but not a single meteor was observed.

Miss Brown, Cirencester.—The sky was perfectly clear on November 13, 11h. 45m. to 13h. 15m., and the eastern sky was watched from a window facing that quarter, but no meteors were seen.

Mr. W. H. Milligan, Belfast.—Cloudy weather prevented observation except on one night, November 13, 11h. to 12h. 30m., when only one sporadic meteor was recorded ; no Leonids.

D. W. Walton, Kingston-on-Thames.—Sky clear and moon bright on November 13, 10h. 30m. to 11h. 30m., but only one meteor appeared. Partly overcast afterwards, but a few faint meteors were noticed in breaks between the clouds.

Bristol.—The writer watched the sky on November 13, between about 11h. 30m. and 13h., but no Leonids were recorded. The sky clouded after 14h., and the following night was overcast throughout. Mr. Corder, at Bridgwater, reports that the nights following November 13 and 14 were too cloudy to permit of observation.

W. Trueman Tucker, Loughborough.—On November 14 the clouds cleared away between 16h. and 16h. 30m., but the moon was very bright, and must have extinguished many of the smaller meteors. Between 16h. 30m. and 18h. a considerable number of shooting stars were observed, but no exact count was kept. The lines and approximate paths of ten of the more conspicuous ones were noted, and the brightest of all appeared in Cepheus at 17h. 25m. It was sufficiently luminous to cast distinct shadows in spite of the moonlight. Very brilliant meteors also fell at 17h. 10m., 17h. 15m., 17h. 35m. and 17h. 40m.

The Dumfries and Galloway Standard of November 17 reports that the nights of November 12 and 13 were overcast. On November 14, soon after midnight, the clouds began to roll off, and the sky afterwards became very clear. An amateur observer began watching at 12h. 30m., and from that time until 16h. 15m. he noted in all only thirty-three meteors, not more than thirteen or fourteen being Leonids. He then, thinking the outlook not sufficiently promising for any striking development of the shower, folded up his note book and star charts and retired. Shortly afterwards, however, the Leonids increased rapidly both in numbers and brilliancy. At about 16h. 50m. "a couple of young bakers going along the Whitesands to their work, were startled by many meteors throwing their fiery lances athwart the sky. They estimate the numbers as not fewer than ten shooting stars to the minute, and state they never saw so many before in all their lives."

The latter description is probably exaggerated, but it seems to convey an expression of fact such as we should expect from persons not acquainted with, but surprised by, an unusual celestial event. Though the rough estimate given as to the number of meteors visible may far exceed the actual figures, there is no doubt from the corroborative testimony afforded by Mr. Tucker at Loughborough, quoted in a previous paragraph, that the Leonid shower displayed quite a special activity on the morning of November 15. That it was apparently observed by few persons is unfortunate, but no other result could be expected in view of the cloud-laden atmosphere which prevailed, generally, at the time. It is to be hoped that more favourable conditions obtained at foreign stations, and that successful observations were secured. The shower seems to have presented itself somewhat later than the time expected, both in 1896 and 1897.

W. F. DENNING.

M. FORSTER HEDDLE, M.D.

EARLY on the morning of November 19 there passed away at St. Andrews the foremost mineralogist of Scotland, and one of the most distinguished in the United Kingdom.

Matthew Forster Heddle was the younger son of Robert Heddle, Esq., of Melsettar, in Orkney, and was born in 1828. In 1844 he went to the University of Edinburgh, where he studied medicine and attended the classes of Gregory and Jameson. Even at this time his tastes lay in the direction of science ; and on the completion of his medical studies he proceeded to Germany, where he devoted himself to chemistry and mineralogy, at first in Clausthal and afterwards under the illustrious Breithaupt at Freiburg. Returning to Edinburgh, he took his degree as Doctor of Medicine in 1851, his graduation thesis being a treatise "On the Ores of the Metals."

He practised for a short time in Edinburgh, but never found this occupation a congenial one, devoting by degrees all his time to analysis and other scientific work. In 1856 he organised an expedition to the Faroe Islands. Five months of the summer of that year were spent in a mineralogical survey of the group, resulting in large additions to his cabinet, and putting on a firm foundation his knowledge of the mode of occurrence of the zeolites of the tertiary volcanoes.

On Dr. Heddle's return from this expedition he was appointed assistant to Prof. Connell at the University of St. Andrews, and on Connell's death, in 1862, he succeeded him as Professor of Chemistry, occupying this chair for twenty-two years. He threw himself with characteristic energy into his work at the University, spending a very considerable part of his salary in the purchase and fitting up of the apparatus for his experiments.

He found time, however, during these years for much mineralogical work, in the course of which he again and again traversed the whole North of Scotland and the Western Islands, thus acquiring an unrivalled acquaintance with its rocks and minerals. The results of these explorations were embodied in a series of papers read principally before the Royal Society of Edinburgh, of which he was, in 1878, elected a Fellow, and the Mineralogical Society, of which he was one of the

founders, and whose President he afterwards became. In addition to these and other papers of a geological and mineralogical nature, he undertook, in 1858, the revision and practically the editorship of Greg and Lettsom's "Mineralogy of Great Britain and Ireland," to which he made many original contributions. He also wrote the article "Mineralogy" for the last edition of the "Encyclopædia Britannica." In 1878 he received the Keith medal of the Royal Society of Edinburgh. Until a few weeks before his death he was engaged on an exhaustive work upon the mineralogy of Scotland, bringing together the results of all his investigations and analyses. This he left almost complete, and it is to be hoped that it may shortly be published.

In the long course of his mineralogical activity Dr. Heddle gathered very large and valuable collections of minerals, both general and Scottish. The latter of these, the fruit of many journeyings, was three years ago acquired by the Museum of Science and Art, Edinburgh, and is now on exhibition there, arranged and labelled by Dr. Heddle himself.

Although a specialist in mineralogy, Dr. Heddle's sympathies were not by any means confined to this subject, and embraced not only cognate sciences, such as chemistry on the one side and geology on the other, but extended to many other branches of science. As a chemist he was most painstaking and exact, and has published several hundreds of analyses of Scottish minerals, collected and carefully picked by himself. He was always most particular to indicate the possible impurities as a geologist. He published detailed maps of Shetland and Sutherland, and contributed to the unravelling of the problem of the North-west Highlands. He was a very observant student of the influence of geological structure upon the scenery of a country. In some respects he was in advance of his time as a geologist, and has lived to see suggestions, which were ignored when made by him, worked out by others and generally accepted. Many of his papers, which were founded on a wide research, are extremely suggestive and instructive. Perhaps among the best known are those where he expounds his law of pseudomorphous replacement, and where he enunciates the connection between the colloidal and crystalline states of a substance and its specific heat.

Dr. Heddle had an acute and exact eye, a clear intellect, and a wonderful memory. He was a good draughtsman, and his crystal drawings were most admirable. He grudged no trouble in smoothing the path of the tyro in his favourite science, and was most generous in his recognition of any work done by others. His kindly and genial disposition endeared him to a wide circle of friends. J. C.

NOTES.

M. MOUREAUX has just completed the installation of the new magnetic department of the Parc St. Maur Observatory; and it will be set in operation on December 1. The work at the old magnetic rooms will be continued until January 1, in order to supply M. Moureaux with a sufficient number of observations for a reduction of the valuable records obtained continuously during a number of years.

PROF. JAMES B. HATCHER, curator of the department of vertebrate palæontology of Princeton University, sailed from New York a few days ago for Rio Janeiro, *en route* for Southern Patagonia. He expects to land finally at Punta Arenas, and thence work northward along the eastern base of the Andes as far as the Argentine territory of Chubut, studying the palæontology and geology of the country. The expedition will be gone three years, and aims to bring home a complete collection of birds and mammals from the Tertiary deposits of Patagonia.

IN the course of next month, the American Philosophical Society will award the Magellanic gold medal to the author of what is adjudged to be the best discovery, or most useful invention, relating to navigation, astronomy, or natural philosophy (mere natural history—the words are the Society's own—only excepted). The prize was founded in 1786 by John H. de Magellan, of London, and consists of a medal "of solid standard gold of the value of ten guineas."

SIR WILLIAM CROOKES will be the guest of the evening at the Club House Dinner of the Camera Club on December 7.

AT the meeting of the Entomological Society of London last week, the Chairman referred with regret to the death, while serving on the Indian Frontier Expedition, of Captain E. Y. Watson, Fellow of the Society, and well known for his writings on Oriental Rhopalocera.

THE Paris Academy of Medicine has been authorised to accept the legacy of forty thousand francs bequeathed to it by Dr. Eugène Dupierris. The legacy is to be used to found a biennial prize for the best work on anæsthesia, or on diseases of the urinary canals.

A NEW medical society has been formed in St. Petersburg; it will be known as the St. Petersburg Ophthalmological Society, and its first president is Prof. Dobrovolski.

THE *Athenæum* states that the first meeting of the present session of the German Chemical Society at Berlin was devoted to a *Gedächtnisfeier* in honour of the late Prof. Victor Meyer.

JUBILEE medals have been conferred upon Dr. Günther, President of the Linnean Society, Prof. Dewar, president of the Chemical Society; and Prof. R. Meldola, late president of the Entomological Society.

PROF. A. BAUER has been obliged, on account of ill-health, to decline the office of president of the third International Congress for Applied Chemistry, which is to be held next year at Vienna, and Dr. H. R. von Perger has been elected in his stead. There will be twelve sections in connection with the Congress. Among the subjects to be discussed is the introduction of uniform methods of analysis of chemical products.

THE Paris correspondent of the *Lancet* notes the return of M. Raoul from Malaita, where he has for some time been engaged for the Government in making researches as to the existence of indigenous plants that might be turned to account scientifically or commercially. Several members of M. Raoul's party were bitten by snakes of different kinds, and were injected with Dr. Calmette's serum with very great success.

DR. A. LUSTIG, writing in the *Atti dei Lincei*, describes some important observations made in India on vaccination as a preventive of bubonic plague, and also on sero-therapic methods of treatment. At the time when the plague was raging in Bombay last June, Dr. Lustig made a number of experiments both on human subjects and on monkeys. Thirty persons suffering from the disease were inoculated with serum, and of these only four died during the treatment. In conjunction with Dr. G. Galeotti, the same writer made experiments on rats with a view of ascertaining whether there existed any hereditary transmission of the immunity conferred by vaccination. It was found that in no case did vaccination of either or both parent animals at any stage prevent the progeny from taking the disease.

IN the Budget of the French Minister of the Interior, the grant of 106,000 francs for the therapeutic serum service of the

Pasteur Institute is set down for payment. In 1895, 45,203 doses of anti-diphtheric serum, each ten centigrams in amount, were distributed gratuituously, and in 1896 the number was 28,217. Since the commencement of the work, as many as 137,058 doses of antitoxic serum have been distributed by the Institute, 5500 of them being for veterinary purposes.

WE regret to announce the death of Dr. F. Stohmann, honorary professor of agricultural chemistry in the University of Leipzig; and also of Dr. J. Frenzel, curator of the "Müggelsee" biological station near Berlin, and formerly professor of zoology in the Cordoba University, Argentine Republic.

THE death of Dr. Leonhard Sohncke, at the age of fifty-five, is announced. Dr. Sohncke at the time of his death was professor of experimental physics and director of the Physical Laboratory at the Munich Technical High School.

THE Natural History Society of Hanover will celebrate its centenary on December 10–12.

IN a previous number of NATURE (vol. lvii. p. 32) we referred to the death of Prof. Ernst Schering, of Göttingen. Some interesting details of his life and work have now been published by Prof. Wilhelm Schur (*Astronomische Nachrichten*, No. 3458), to which brief reference may be made. Born in the year 1833 at Sandbergen, near Lüneburg, Schering studied in Göttingen under Gauss from the year 1852, was made "ausserordentlicher" professor in 1860, and "ordentlicher" in 1868. In 1869 the magnetic part of the observatory department was made distinct from the astronomical, and the former put under the direction of Schering with the object of continuing the magnetic observations made in the first instance by Gauss. After Klinkerfues' death Schering took over the direction of both departments. During the years 1858 to 1863 Schering took part with Klinkerfues in the zone-observations, which were published in 1891. In 1874 he published a generalisation of Poisson-Jacobi's perturbation formulæ, in 1877 a "Festrede" at the celebration of the hundredth anniversary of Gauss's birthday, and in 1884 a solution of Kepler's equation (*Astronomische Nachrichten*, 2605). His chief work was, however, the publication of Gauss's works in seven volumes. Schering leaves behind him, besides a widow, one daughter and two sons.

Science states that the American Society of Naturalists and the affiliated societies will meet at Ithaca, N.Y., on December 28, 29 and 30. At the opening meeting an address of welcome will be delivered by President Schurman. On the second day of the meeting the principal item on the programme is a discussion on "The Biological Problems of To-day," in which the following speakers will take part: Prof. H. F. Osborn (on Palæontology), Prof. W. Trelease (on Botany), Prof. B. G. Wilder (on Anatomy), Prof. McKeen Cattell (on Psychology), Prof. J. Loeb (on Physiology), Prof. T. H. Morgan (on Developmental Mechanics), Prof. C. B. Davenport (on Morphogenesis).

PROF. TH. W. ENGELMANN, of Utrecht, has just published (Wilhelm Engelmann, Leipzig) a small case (6½ × 9½ inches) containing two sets of tables on which it is intended the results of spectroscopic and spectrophotometric observations may be plotted. The first table, of which there are nine duplicates, consists of six coloured continuous spectra arranged under one another, which serve as a background, so to speak, on which absorption spectra may be drawn. A series of vertical lines forms the scale of wave-lengths, and the positions of the chief Fraunhofer lines are marked in the upper strip. The second table, of which there are also nine similar ones, is somewhat differently arranged. At the upper part is a coloured continuous spectrum as before, with the positions of the chief Fraunhofer lines marked, and below is a series of horizontal and vertical lines, the former to represent the wave-lengths, and the latter the intensities per cent. This will be found useful for recording the positions and extensions of absorption-bands, and determining the light-curve of the spectra under investigation. Both these sets of tables are impressed on good thick sheets of paper, and the coloured spectra and graduations are very neatly reproduced. It is a pity that the red end of the spectrum is placed on the left, and not on the right hand, as this may tend considerably to diminish the usefulness of these cards. Accompanying these sheets are also two numerical tables expressing (1) the coefficients of extinction for different intensities, and (2) the relative intensities after the passage through coloured media of different thicknesses.

THE *Proceedings* of the Liverpool Geological Society for the last session contains a paper by the president, Mr. J. Lomas, on the Hereford earthquake of last December. The map which accompanies it shows the isoseismal lines, so far as they can be drawn, corresponding to the intensities 4, 5, 6 and 7 of the Rossi-Forel scale. These curves are somewhat elliptical in shape, and are grouped symmetrically about a line running N.N.W. from a point a little east of Hereford. Mr. Lomas attributes the earthquake to the friction generated by the slipping of strata somewhere along the Severn Valley, and he considers it probable that the slip extended for some distance along the axis of the isoseismals.

THE effect of temperatures upon the hibernation of injurious insects forms the subject of a short paper by Dr. L. O. Howard in the *Proceedings* of the ninth annual meeting of the Association of Economic Entomologists, just issued by the U.S. Department of Agriculture. It is a well-known fact among agriculturists and horticulturists that winter weather of a steady degree of severity is more favourable to plant growth than a winter with alternating frosts and thaws. With regard to certain injurious insects, it has become an accepted idea among economic entomologists that this same principle holds good, but farmers and others believe a winter which has been unusually severe will result in the destruction of injurious insects to such an extent as to promise comparative immunity in the next season. Experiments were required to throw light upon the matter, and these have been carried out by Dr. Albert M. Read, of Washington, the manager of the cold storage department of the American Security and Trust Company. Dr. Read has found, in the course of his experiments, that a consistent temperature in the neighbourhood of 18° F. will not destroy the larvæ of *Tineola biscelliella* or of *Attagenus piceus*, but that an alternation of a low temperature with a comparatively high one invariably results in the death of the larvæ of these two insects. For example, if larvæ of either which have been kept at a temperature of 18° F. are removed to a temperature of from 40° to 50° F. they will become slightly active, and when returned to the lower temperature and kept there for a little time, will not revive upon a retransfer to the warmer temperature. Dr. Howard remarks that it is satisfactory to have experimental proof in support of previously accepted, but more or less theoretical, ideas.

AT the Imperial Institute on Monday night, Mr. E. S. Bruce gave a lecture on his system of electric balloon signalling as applied to scientific exploration in Arctic and Antarctic regions. Major P. A. MacMahon was in the chair. After pointing out how great an advantage it would be for a party to have a means of communicating with the ship when away on an exploring expedition, the lecturer described his system, in which a group of electric lamps was mounted inside a balloon connected with the earth by an electric cable. The operator and most of the

apparatus would be on the ground or the deck of a ship, and therefore the balloon could be made easily portable. Gold-beaters' skin would be the best material to employ for the covering, and the smallest size of balloon he could recommend for Arctic exploration purposes would be about 7 feet in diameter, with a capacity of 150 cubic feet and able to lift 500 feet of cable. The necessary gas could be stored in steel tubes, or a portable gas-making machine might be carried. The source of electric power would be a dynamo, with which Mr. Bruce supposed every future Arctic expedition would be provided, and this could be operated by wind power, if coal ran short, or even by hand. By giving long and short flashes on the lamps, it would be possible to convey messages in the Morse alphabet.

SOME time ago, G. Jung gave a solution of the problem "to determine by the method of least squares the plane which most nearly coincides with n non-coplanar points." In the *Rendiconti del R. Istituto Lombardo*, ii. xxx. 16, a brief abstract is given of an investigation by the same writer of the reciprocal problem: "Given n non-concurrent planes, to find the point most nearly determined by them." The corresponding problem in plane geometry has been attacked by M. d'Ocagne, and Prof. Jung has thus extended the method to three-dimension space, besides giving a generalisation of certain constructions first investigated by M. Berthot.

IN the *Journal of the Royal Statistical Society* (September), Mr. W. F. Sheppard considers the calculation of the average square, cube, &c., of a large number of magnitudes. Supposing that a number of measurements are tabulated to the nearest multiple of a particular unit (*e.g.* the chest measurements of 5732 Scotch soldiers to the nearest *inch*), the data do not enable us to find *exactly* the true average measurement or the average square or cube of the magnitudes. Mr. Sheppard shows that the *rough value*, obtained by supposing each measurement to be equal to the nearest multiple of the unit, differs in some cases considerably from the *most probable* value of the average in question, and he finds that for laws of distribution which satisfy certain conditions a very close approximation to the latter may be obtained by applying certain simple corrections to the "rough values" first calculated.

IN the *Mathematical Gazette* for October we are glad to see that Mr. R. F. Muirhead calls attention to the old treatment of the "Parallelograms of Velocities and Accelerations," which still survives in many otherwise excellent text-books on dynamics. The enunciation often introduces the notion of "a moving point or body possessing simultaneously two velocities," a notion which is meaningless until coexistent velocities (which would better be spoken of as "velocity components") have been defined. The usual (so-called) "proof" tacitly involves the idea of a body *moving relatively* to a certain base which is itself in motion, but as the word "relative" is generally omitted, and the parallelogram of velocities is usually given before relative motion is considered, and, moreover, is employed in the discussion of relative motion, the learner's mind is often puzzled and he fails to grasp the theorem. Mr. Muirhead rightly contends that the only logical way out of the difficulty is to make relative motion precede the discussion of the parallelogram law, unless, indeed, the latter be regarded merely as a *definition* of component velocities and acceleration.

WE have received from Mr. R. C. Mossman a copy of a very valuable and laborious investigation of the Meteorology of Edinburgh, based upon observations during the past 132 years, from documents mainly collected by the Scottish Meteorological Society. The work is published in the *Transactions* of the Royal Society of Edinburgh, and is divided into two parts, the first dealing with the climatic elements for each day of the year, and the second with monthly and annual means, and with secular and other weather changes. The smoothed curves show that the warmest day of the year falls on July 15, and the coldest on January 8. The mean daily maximum temperature is above the annual average (46°·8) from April 26 to October 14, but the mean minimum does not get above the yearly mean until May 12, and it remains above it till October 19. The greatest excess of sun over shade temperature was 76°·8 in March 1892, and the grass minimum thermometer fell 12°·6 below the minimum in shade in May 1890. The mean annual rainfall is 25·86 inches; the wettest period is that embraced in the seven days ending August 18; while the period distinguished by the least rain-fall, is the week ending with March 27. One very interesting feature of the discussion is a chronological appendix of remarkable atmospheric phenomena at Edinburgh, extending from 1575 to 1895, which has been compiled from a variety of sources.

A NOTE in *Science* states that Dr. O. Holst, of the Geological Survey of Sweden, after two years' leave of absence granted him for the purpose of studying the new gold-fields in Western Australia, has now returned. Dr. Holst saw the ancient Australian glacial deposit which is supposed to belong to the Permian age, and says there can be no doubt but that it is an indurated boulder-clay. Its age may possibly be somewhat later than heretofore supposed, but not so much later as to detract from the importance of its bearing on the subject of geological climate. In the semi-desert, where Dr. Holst spent most of his time, the wind did not appear to him to be of any great importance as a geological agent, although dust storms are sometimes reported from the new towns on the border of the desert. One of the Australian geologists has lately made some interesting observations on what resembles a tidal action of the ground water in the sandy region in the interior. The water rises and falls at regular daily intervals, and the oscillations appear to be too great to be explained as resulting from the daily variations in atmospheric pressure.

THE *Electrician* calls attention to a new development in the design of electrically-propelled pleasure craft, which has been given the name of the "Nymph." Briefly, the "Nymph" is an attachment to an ordinary pleasure boat, sailing ahead of it but rigidly connected to it, the boat containing the accumulator cells and the switch-gear by which is controlled the motor in the body of the swan-shaped tug. The craft is guided or steered by two reins attached to the head of the "swan," and these reins actuate by gear the ordinary rudder. A regulator situated close to the right-hand of the driver enables him to control the speed of the motor and propeller in the "swan," and to go at full or half-speed, ahead or astern. There are sixteen chloride cells of seventeen plates each, and these, for starting and low speeds, are connected to the motor in two parallels of eight cells each, all the cells being used in series for full speed. The total electrical capacity of the battery is about 300 ampere hours, and this is equal to propelling the boat at a speed of eight miles an hour for six hours, or a total distance of about fifty miles, with six people on board. No resistances are used, and neither the field nor the armature is divided up in any way to regulate the speed. The vibration of the boat is perceptibly less than in one containing the motor. Although the arrangement lends itself to graceful design, there is probably considerable loss of efficiency as compared with the usual stern propeller.

THE Commission appointed by the German Government to study the plague in Bombay, and which commenced its work under the presidency of Prof. Dr. Gaffky last March, has published the results of its labours in several numbers of the *Deutsche medicinische Wochenschrift*. The report is a very elaborate and exhaustive one, and contains a mass of valuable

experimental material. It would appear that in the majority of cases the plague-bacillus obtains access to its victims through small wounds or scratches on the body, reminding one of the same method adopted by the anthrax bacillus for infection. As Yersin has already pointed out, plague is essentially a disease which afflicts the poor and miserably-housed lower classes of the population, their habits and repugnance to all sanitary precautions, and prejudice against the hospitals, rendering its suppression a matter of extreme difficulty. In the hospitals, thanks to systematic disinfection and scrupulous cleanliness, cases of plague amongst the staff were very rare. The Commission have discovered that the serum of human beings, as well as that of animals which have recovered from plague, exerts a specific action on plague bacilli outside the body, producing the phenomenon of the clumping together of the bacilli now so familiar in the case of typhoid bacilli under similar circumstances. Numerous researches were carried out to test the vitality and powers of endurance possessed by these bacilli under very varied conditions. For example, in sterilised tap-water they were found to be dead after three days, whilst in ordinary tap-water a single day's immersion was sufficient to destroy them. Very sensitive also are these microbes to the action of disinfectants, corrosive sublimate diluted to 1 in 1000 parts at once destroys them, whilst a 1 per cent. solution of carbolic acid also kills them within ten minutes. Heating for ten minutes at 55° C. destroys them, as also does exposure to a temperature of 80° C. for five minutes, whilst in a liquid just brought to the boiling point, and at once examined, they were also entirely annihilated. Perhaps the most interesting part of the report is that which deals with the inquiries made into the respective merits of Yersin's and Haffkine's anti-plague inoculations. Yersin's serum inoculations in Bombay do not appear to have been as successful as those which he previously carried out in cases of plague at Amoy. Dr. Roux was, however, preparing a yet stronger serum at the Paris Pasteur Institute, and it was hoped that it might prove more efficacions. On the other hand, Haffkine's inoculations appear to have been very successful, although the protection against plague afforded by them is by no means absolute. Haffkine's method consists in adding a weak solution of carbolic acid or essence of mustard to a virulent growth of plague bacilli, thereby destroying the microbes; their products, however, which remain, possess a remarkable protective power. The vaccine may also be procured by heating the plague-cultures to 65° C. for one hour, or during two hours to 51° C. This method of heating appears to yield the best vaccine. It is impossible here to enter into further details of this valuable report, which forms a most important contribution to the scientific literature already existing on plague and its dissemination.

MR. CHARLES LOUIS HETT, of Springfield, Brigg, has prepared a list of the calls of some two hundred British birds, and appeals for the assistance of other students of bird-life, either in checking calls already recorded, or in supplying those of other birds. He promises to finish the compilation and to issue it from the press, provided he receives the co-operation needed.

HERREN MAYER AND MÜLLER, of Berlin, ask for subscriptions for an important work on Orchids, of which the first volume is already in type—"Orchidacearum Genera et Species," by Prof. F. Kraenzlin, to be completed in six volumes. No complete separate systematic work on the Orchidaceæ has been published since Lindley's Synopsis, which was issued sixty years ago.

COHN'S "Kryptogamen-Flora von Schlesien" is a work of much more than local interest, the various families of Cryptogams having been worked out with the greatest care by experts in the various departments. The last part received (3er Band, 2te Hälfte, 4te Lieferung) completes the Pyrenomycetes, and contains an introduction to the so-called "Fungi imperfecti," those in which the conidial, but not the ascogenous form is known. This portion of the work will, unfortunately, remain uncompleted, as it stood in the hands of Dr. J. Schröter at the time of his death in 1894, Prof. Cohn not having been able to find any one to complete the work left unfinished by that eminent mycologist. An interesting feature of Dr. Schröter's work in this section of Fungi is that he has discarded the term genus, arranging the species under *Formgattungen* or "form-genera."

MESSRS. ROSS, LTD., have just issued a very full illustrated catalogue of the instruments made by them.

MESSRS. ABBOTT, JONES, AND CO. announce for early publication "The Life of James Abernethy, past-president of the Institute of Civil Engineers." The book will be the work of John S. Abernethy, and will be illustrated.

THE sixteenth Annual Report of the Bureau of American Ethnology has reached us, and contains the following papers:—"Primitive Trephining in Peru," "Cliff-Ruins of Canyon de Chelly, Arizona," "Day Symbols of the Maya Year," and "Tusayan Snake Ceremonies."

THE catalogues issued from time to time by Mr. Bernard Quaritch are always interesting, but few, if any, of those recently issued can compare with the one dated November 12, which has just reached us. It is entitled "Monuments of Printing," and contains particulars of books produced by the earliest presses in Germany, the Netherlands, Italy, France, Spain and England from 1455 to 1500, and a few remarkable examples of a somewhat later date. The catalogue is one which will be prized by all students of typography.

THE *Photogram* for November contains several short articles of interest to photographers. Mr. C. F. Townsend writes about sensitometers, giving a brief historical summary of the methods employed. Under the heading of "Applied Photography in Ship Salvage Work" is the title of an article by Mr. Charles H. Evans, who points out the many difficulties that are met with in this class of work. The illustrations accompanying the text are very much to the point, being good examples of the work undertaken. Other branches of the art dealt with are photo-micrography, exact measurements with the X-rays, toning bromide prints, &c., together with useful information in the form of notes on many other points of interest.

VOLUME V. of the *Transactions* of the Institution of Mining and Metallurgy for the sixth session has reached us, and is a bulky work, containing reports of some eighteen papers, and the discussions which took place upon them. The Institution during the session referred to had upon its books the names of 449 members, associates and students, as against 372 for the session of 1895-96.

MESSRS. MACMILLAN will publish shortly a work entitled "A Text-Book of Zoology," under the joint authorship of Profs. T. Jeffery Parker and W. A. Haswell. Special attention is called to the illustrations, of which there are over a thousand in the two volumes that comprise the work. For the most part these illustrations are original, and have been drawn by Mr. N. J. Parker.

OF all the periodicals which come before us week by week, and month by month, not one fulfils its particular purpose better than the *Engineering Magazine*. The magazine is always attractively illustrated; the articles in it deal with subjects which are of prime importance in the engineering world; and the monthly digest of the entire technical press is a very valuable

index to current technical literature. The issue of a distinctly European edition of the magazine was commenced last month, and we are confident that it will meet with as much success here as it has in the United States.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. F. Greswolde-Williams; a Suakin Gazelle (*Gazella brookii*) from Abyssinia, presented by Dr. L. de Gebert; two Ring-necked Parrakeets (*Palæornis torquatus*) from India, presented by Mrs. G. F. Cooper; a Macaque Monkey (*Macacus cynomolgus, albino*) from Manilla, presented by Mr. James Coombs; two Double-spurred Francolins (*Francolinus bicalcaratus*) from West Africa, four Rosy Bullfinches (*Erythrospiza githaginea*), bred in England, presented by Mr. E. G. B. Meade-Waldo; two Herring Gulls (*Larus argentatus*), British, presented by Mr. T. Hope Robinson; two Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), two —— Snakes (*Chlorophis hoplogaster*), a Puff Adder (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; a Ring-tailed Lemur (*Lemur catta*, ♀) from Madagascar, a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; six Rosy-faced Love Birds (*Agapornis roseicollis*) from South Africa, a Malaccan Parrakeet (*Palæornis longicauda*) from Malacca, four Siskins (*Chrysomitris spinus*), four Lesser Redpolls (*Linota rufescens*), British, a Bridled Wallaby (*Onychogale frenata*) from Australia, a Loggerhead Turtle (*Thalassochelys caretta*) from the Mediterranean, purchased.

OUR ASTRONOMICAL COLUMN.

THE NOVEMBER METEOR SWARMS.—Up to the present time we have not received any news that the Leonids were more abundant this year than last. Indeed, bad weather seems to have universally prevailed about the time of observation. At the Paris Observatory five observers only noted twenty meteors, while M. Hansky, at the Meudon Observatory, saw in all seven, four of which were Leonids. M. Janssen, in consequence of the exceedingly bad weather experienced in Western Europe, telegraphed to San Francisco to inquire whether a more brilliant display had been noted there. The answer he received was to the effect that nothing more than the ordinary shower was observed. Perhaps, however, observers may be (or may have been) more fortunate with the Andromedes, which are expected between the 23rd and 27th of this month. This swarm is also of considerable strength, and should be more than usually active Its period of revolution being six and a half years, and the last maximum having occurred on November 23, 1892, we expect the shower this month to be above the ordinary yearly display. There are several points about the Andromedes that are of peculiar interest. One of these is that the orbit in which they move is very similar to that of the comet Biela; in fact, the bodies which produce the phenomena of shooting stars may be none other than the component parts of this comet. In the years 1872 and 1885 the maximum display occurred on the 27th of the month, but at the following expected shower it took place on the 23rd. This difference is explained, according to Bredichin, by the perturbatory effects due to the proximity of the planet Jupiter, thus causing the node to recede 4°. The radiant point of this swarm (25° + 43°) has a large northern declination, which renders it always above the horizon. The meteors themselves are different from the Leonids in that they move more slowly, and are of a yellowish tinge.

In the note under this heading, that appeared last week, it should have been mentioned that the observations recorded were made by Dr. W. J. S. Lockyer at the Solar Physics Observatory, South Kensington.

In another part of this journal Mr. Denning summarises the results of this year's Leonid display.

CURRENT ASTRONOMICAL ARTICLES.—M. Gaston Armelin contributes an interesting article on that curious variable Mira Ceti to *La Nature* for November (No. 1274). After a brief historical summary the writer describes some theories current to-day, and points out the variations in the time of maxima observed of late years, and their consequent suggested explanations.—The bulletin of the *Société Astronomique de France* for the same month contains, among other interesting matter, a drawing of comet Perrine as observed at the observatory of Juvisy. M. Camille Flammarion deals with the Leonid swarm of meteors. The number contains several contributions of planetary notes.—In the October number of *Himmel und Erde*, a brief account is given of the present state of the proposed large Potsdam refractor. There seems to have been some difficulty about the optical parts, so that it has been decided to assume that the aperture will be 80 cm., and commence at once with the construction of the instrument and a suitable dome. This instrument when finished will be then the largest in Europe, the aperture being nearly thirty-two inches. This article contains the results of many investigations on the absorption properties of different thicknesses and kinds of glass.

COMET PERRINE (OCTOBER 16).—This comet is gradually becoming fainter, but a continuation of the ephemeris for the current week will perhaps prove useful:—

12h. Berlin M.T.

1897.	R.A. h. m. s.	Decl. ° ′ ″	log r.	log Δ.	B.
Nov. 25 ...	18 16 49 ...	+ 59 24·6			
26 ...	15 45 ...	58 44·8 ...	0·1376 ...	0·0278 ...	07
27 ...	14 47 ...	58 6·4			
28 ...	13 54 ...	57 29·3 ...	0·1366 ...	0·0370 ...	07
29 ..	13 6 ...	56 53·4 ,			
30 ...	12 23 ...	56 18·8 ...	0·1357 ...	0·0459 ...	07
Dec. 1 ...	11 43 ...	55 45·5			
2 ...	11 7 ...	55 13·5 ...	0·1351 ...	0·0546 ...	07
3 ...	18 10 34 ...	+ 54 42·4			

REV. DR. SEARLE has resigned the directorship of the astronomical observatory of the Catholic University of America. His place will be taken by Mr. Alfred Doolittle.

THEORY OF THE MOTION OF THE MOON.[1]

OF the lunar theories hitherto completed the two greatest are undoubtedly those of Hansen and Delaunay. The former has for its chief object the formation of tables: the inconvenience of slowly converging series is avoided by using numerical values throughout; and the problem solved is the one actually presented by nature, every known cause of disturbance being allowed for. It suffers, however, under the disadvantage that there are no means of correcting the results for any change in the values of the constants that observation may demand. This drawback was avoided by Delaunay, but only at the expense of still greater evils from the point of view of the making of an ephemeris; for owing to the slow convergence of certain series, twenty years' labour did not suffice to give sufficiently approximate results; moreover, the problem had to be considerably modified from the circumstances of nature, in order to achieve a result within even so long a time.

The memoir that Dr. Brown has lately presented to the Royal Astronomical Society, forms the first part of a fresh attempt to calculate the motion of our satellite. All Delaunay's modifications of the problem are adopted: that is to say, the sun and earth are supposed centrobaric, the mass of the moon is neglected, as is also the action of the planets, and the true mass of the sun is increased by that of the earth. The calculation of the effect of the attraction of the planets and of the protuberant parts of the earth's equator will follow when the modified problem is solved. The solution can also be easily modified so as to allow for the greater part of the effect of the remaining modifications, and the outstanding error Dr. Brown has shown to be insensible to observation; but it is, however, far larger than the minute fraction of a second to which his calculations are pushed.

Dr. Brown's theory resembles Delaunay's in being algebraical with, however, one important exception: the ratio of the mean motions is replaced by its numerical value. By this means the slowly converging series that occur in Delaunay's theory are avoided; and no admissible correction of the value of the above ratio can introduce any change in the results that would be sensible to observation. This modification in the form, combined

[1] "Theory of the Motion of the Moon." Containing a new calculation of the expressions for the coordinates of the Moon in terms of the time." By Ernest W. Brown, M.A., Sc.D. (Reprinted from the *Memoirs* of the Royal Astronomical Society, vol. liii.)

with the use of a totally different method of calculation will, Dr. Brown estimates, cut down the twenty years occupied by Delaunay over the same problem to five.

One great advantage of an algebraical theory is the facility with which the work can be divided into sections, each consisting in the calculation of a group of terms multiplied by the same power of the eccentricities, inclination, and solar parallax, or, in the language of the lunar theory, having the same characteristic. Delaunay's theory unfortunately lost this advantage by its peculiar methods, and substituted another form of subdivision that enormously increased the total labour in the desire to present each step in a moderate compass. Adams appears to have been the first to clearly recognise the advantages of a subdivision such as Dr. Brown has employed, but it was Dr. Hill who actually laid the foundations of the present theory. In the first volume of the *American Journal* he published his famous "Researches in the Lunar Theory," where, after the lapse of more than a century, he revived Euler's idea of using rectangular coordinates. Confining his investigations to the case when the eccentricities, inclination, and solar parallax are supposed to vanish, he used axes rotating so that the axis of x points constantly to the sun, and then replaced x, y by the conjugate complex variables u, $s = x \pm y\sqrt{-1}$, and the time by another complex quantity $\zeta = e^{(n-n')t\sqrt{-1}}$, and the symbol of differentiation by D defined as $\zeta \frac{d}{d\zeta}$. He also used the symbol m to denote the ratio of the synodic month to the sidereal year, and k to denote the mass of the earth divided by the square of the difference of the mean motions of the moon and the sun. He then arrived at the differential equations,

$$(\mathrm{D} + m)^2 u + \tfrac{1}{2} m^2 u + \tfrac{3}{2} m^2 s - \frac{ku}{(us)^{\frac{3}{2}}} = 0$$

$$(\mathrm{D} - m)^2 s + \tfrac{1}{2} m^2 s + \tfrac{3}{2} m^2 u - \frac{ks}{(us)^{\frac{3}{2}}} = 0.$$

At this point arose a difficulty which, in a closely analogous form, is common to all lunar theories, the presence, that is to say, of the quantity denoting the mass of the earth divided by the cube of the distance. The practical convenience of a theory is perhaps in no way better tested than by examining the manner in which this difficulty is overcome, and it is certainly not too much to say that in this respect Dr. Hill's method has no rival. In a few brief steps he succeeds in eliminating the obnoxious quantity altogether, and he obtains two equations of the second degree in u, s and homogeneous in these variables except for a constant of integration, which may be looked upon as replacing k. These equations are easily solved numerically, and denoting the values of the variables with Dr. Hill's modifications of the general problem by the suffix zero, u_0 and its conjugate complex s_0 may be henceforth looked upon as known functions of the time. They are, in fact, capable of expression as infinite series of positive and negative odd powers of ζ. The coefficient of ζ in u_0 is denoted by a, which is a constant defining the linear dimensions of the orbit. By having recourse to one of the original equations containing k, the value of k/a^3, which is a mere number, may be found. This completes the investigation of the variation, as this class of inequalities is called.

It is at this point that Dr. Brown took up the subject. He replaced Dr. Hill's first pair of equations by the following set of three, the third of which determines z or the moon's coordinate perpendicular to the ecliptic, which in the particular case treated by Dr. Hill is zero

$$(\mathrm{D} + m)^2 u + \tfrac{1}{2} m^2 u + \tfrac{3}{2} m^2 s - \frac{ku}{(us + z^2)^{\frac{3}{2}}} = -\frac{\partial \Omega_1}{\partial s}$$

$$(\mathrm{D} - m)^2 s + \tfrac{1}{2} m^2 s + \tfrac{3}{2} m^2 u - \frac{ks}{(us + z^2)^{\frac{3}{2}}} = -\frac{\partial \Omega_1}{\partial u}$$

$$(\mathrm{D}^2 - m^2) z - \frac{kz}{(us + z^2)^{\frac{3}{2}}} = -\tfrac{1}{2}\frac{\partial \Omega_1}{\partial z}.$$

In these equations Ω_1 represents the part of the disturbing function neglected by Dr. Hill, every term of which is divisible by either the solar eccentricity or parallax. The quantity k can be eliminated from the first two of these equations in a manner analogous to the methods of Dr. Hill. It can be also eliminated from the third and either of the other two in an obvious manner. The resulting equations need not be written down here; following Dr. Brown, they will be alluded to as the homogeneous equations. There are thus two distinct sets of equations that can be used at any step in the work. In practice one set is used, and a single equation from the other set is used in addition, generally as a mere equation of verification, but in certain special cases for the actual solution when the equations of the first set are not well adapted for the purpose. Dr. Brown's procedure is as follows: let

$$u = u_0 + u_\mu + u^\lambda \qquad z = z'_\mu + z_\lambda$$

Where u_μ, z_μ denote the terms already calculated, u_λ, z_λ the new terms of characteristic λ to be calculated in the next step of the process of solution. Either u_λ or z_λ is always zero according as λ contains an odd or even power of the inclination. These values are then substituted in either set of differential equations, and the terms of order λ picked out. It can be readily seen that the right-hand side of the equations contain only known terms, and the unknown new terms occur in the first degree and multiplied by functions of u_0 s_0 only. If the first set of equations be used, the terms containing k/r^3 must be expanded by Taylor's Theorem into series proceeding according to powers of $u_\mu + u_\lambda$, $s_\mu + s_\lambda$, $z_\mu + z_\lambda$ with coefficients containing k, u_0, s_0 only. These coefficients are easily deducible from Dr. Hill's value of u_0, the method of special values being in general used. One remark, however, requires to be made. Every time a set of terms is calculated whose arguments are the same as the terms in u_0, there arises the opportunity of modifying the meaning of the linear constant a. It is otherwise evident that any solution remains a solution when a is replaced by a new constant a' defined by the relation $a/a' - 1 =$ an arbitrary series of powers and products of the squares of the eccentricities, inclination, and solar parallax. The value of k is of course simultaneously modified also. Consequently we should be liable to have the values of such quantities as k/r_0^3 varying from time to time as the approximation proceeds. This would be obviously inconvenient, and Dr. Brown has used the power of modification at his disposal so that k/a^3 remains invariable throughout the solution, and therefore, since in Dr. Hill's papers it is a function of m only, it always remains so.

In the first set of equations therefore the unknown terms enter in the form

$$\zeta^{-1}(\mathrm{D} + m)^2 u_\lambda + \mathrm{M}\zeta^{-1} u_\lambda + \mathrm{N}\zeta s_\lambda$$

and

$$\mathrm{D}^2 z_\lambda - 2\mathrm{M} z_\lambda$$

where

$$\mathrm{M} = \tfrac{1}{2}m^2 + \tfrac{1}{2}\frac{k}{\rho_0^3}$$

$$\mathrm{N} = \tfrac{3}{2}m^2\zeta^{-2} + \tfrac{3}{2}\frac{k u_0^2 \zeta^{-2}}{\rho_0^5}$$

the same form at every approximation. (A misprint in the algebraical value of N, on p. 63, should be noticed; the factor ζ^{-2} being there omitted. This is merely a printer's error, for the arithmetical value on p. 90 is correctly given. Indeed, were it otherwise, the discordance of the results from those of other theories would long ago have been noticed.)

When the new terms to be calculated have the same arguments as u_ϵ or z_ϵ, the principal elliptic or inclinational terms, a new term in the motion of the perigee or node (of order λ/e or λ/k) has to be calculated. The unknown term $c_{\lambda/e}$ appears multiplied by $2(\mathrm{D}+m)u_\epsilon$ in the first equation, and $g_{\lambda/k}$ appears multiplied by $2\mathrm{D}z_k$ in the second equation. These coefficients are independent of λ: since, however, λ must be of at least the third order for the point to arise, it does not properly enter into the part of the work already published.

A series with indeterminate coefficients is then assumed for u_λ or z_λ: and a number of simultaneous equations formed, from which the coefficients are found. The labour of forming the known terms in these equations increases rapidly with the characteristic; but the operations required are mere multiplication of series, and can to a great extent be left to a computer. The results are readily checked by computing independently the value when $\zeta = 1$.

The unknown terms enter at each step into the equations under the same algebraical form, or rather under one of two forms, according as the new terms belong to u or z. These forms unfortunately involve the symbol of differentiation D, so that the different sets of simultaneous equations have different arithmetical coefficients; but whenever more terms with an old set of arguments are being calculated, the arithmetical coefficients are the same as before, and it is only the right-hand sides which are different. This greatly facilitates the labour of solution; but the advan-

tage is obviously one that is deferred to the later stages of the work, the only instances in the part of the work hitherto published being that the calculations of sections (v.) and (viii.) of chapter iv. are to some extent facilitated by the previous calculation of section (ii.) of the same chapter.

The ordinary method of approximation in the simultaneous equations proceeds by determining approximate values of the unknown quantities in order of magnitude, at first neglecting the smaller of these quantities in the equations of principal importance for determining the larger ones. It happens, from a well-known cause, that sometimes the coefficients of certain unknowns are small even in the equations of principal importance in determining them. Prof. Brown has, in these cases, found it best to defer their determination until he has found all the other quantities in terms of them.

After considerable experience of both sets of differential equations, Prof. Brown has come to the conclusion that the first set on the whole is the best adapted to the numerical work. An important exception, however, arises. The two coefficients of a term of long period are principally determined by two equations very nearly deducible, the one from the other, the determinant of the coefficient varying inversely as the square of the period. The difficulty is considerably lessened by using one equation derived from the homogeneous set.

The following table will give some idea of the extent of the calculations already performed. The terms have been calculated

Reference Number.	Characteristic.	Argument.	Number of Terms.	Approximate value in arc of the largest coefficient (1) including (2) excluding purely elliptic terms.		Value of unity in the last figure given in millionths of a second of arc.
1*	1	0	13	206″265	1″800	0·0002
2	e	$\pm l$	18	17000	3000	2
3	e'	$\pm l'$	21	350	350	0·4
4	α	D	9	80	80	0·05
5	k	F	11	9000	300	0·01
6	e^2	$\pm 2l$	21	240	170	3
7	e^2	0	11	340	100	3
8	ee'	$\pm (l + l')$	21	140	140	4
9	ee'	$\pm (l - l')$	22	100	100	4
10	e'^2	$\pm 2l'$	18	6	6	0·6
11	e'^2	0	10	2	2	0·6
12	k^2	$\pm$ 2F	20	400	40	0·4
13	k^2	0	11	400	40	0·4
14	$e.\alpha$	D $\pm l$	19	12	12	0·6
15	$e'.\alpha$	D $\pm l'$	20	14	14	0·1
16	α^2	0	9	0·01	0·01	0·1
17	ke	F + l	10	15	15	0·06
18	ke	F − l	11	45	45	0·06
19	ke'	F + l'	10	1	1	0·01
20	ke'	F − l'	11	0·4	0·4	0·01
21	$k\alpha$	D + F	10	4	4	0·02

* Calculated by Dr. Hill.

in twenty-one groups, the order of calculation being indicated by the number in the first column. The second column gives the multiple of the eccentricities, inclination, and ratio of parallaxes that is common to each coefficient of the group. The third column gives the fundamental argument from which all the other arguments are derived by the addition or subtraction of multiples of twice the elongation, Delaunay's notation being used, The fourth column gives the number of terms calculated. The fifth column gives the approximate value in arc of the largest coefficient, and the sixth column the value of the largest coefficient indicating a disturbance from elliptic motion. The last column gives the value in arc of the last significant figure, and where, as often happens, the coefficients of a group have been calculated to a different number of decimal places, then the number given in this column corresponds to the coefficient calculated with least accuracy.

Dr. Brown gives as the approximate values of the constants in the third column of the above table

$$e = 0{\cdot}11 \qquad e' = 0{\cdot}017 \qquad k = 0{\cdot}045 \qquad \alpha = 0{\cdot}0026$$

It will be seen that the terms calculated include all that ar algebraically of the second order. The ratio of the parallaxe is here considered as being of the first order. The terms depending on the square of this ratio, it will be noticed, are in sensible to observation. This is fortunate, as the terms cannot be corrected for the neglected mass of the moon.

We think that the results selected for publication are a little too meagre. They consist of the actual solution itself, and one other set of terms whose calculation divides the labour of each section into two fairly equal halves. We hope that an appendix will be finally published in which the value of every auxiliary quantity will be given. Such an appendix might be of great use in other investigations. It would also be of immense value should there ever be a suspicion of error in Dr. Brown's own calculations, for it would then be far easier to establish the fact of such an error, should one ever creep in, and it would entail less labour to carry through the correction.

MARINE BIOLOGY AT THE BERMUDAS.

AN expedition of the biological department of New York University went to the Bermudas a few months ago to study the marine fauna, and to investigate the conditions offered for the establishment of a permanent biological station there. The party has now returned, and an account of the observations made is contributed by Prof. C. L. Bristol to *Science*, from which source the following particulars have been derived :—

The most attention was given to a search for the various forms and a careful survey of the general conditions subtending their abundance and collection, so that, taken as a whole, the work might prove a reconnaissance and furnish knowledge for future investigations. In this the expedition was fairly successful and would have been much more so but for a long spell of south-west wind which prevented off-shore work, excepting for a few days. Our work was confined mainly to the lee shores, and here we were greatly rewarded. Of corals the genera *Diploria*, *Meandrina*, *Astrea*, *Siderastrea*, *Porites*, *Isophyllia*, *Oculina* and *Mycedium* were found ; of Gorgonians, *Rhipidogorgia* and *Gorgonia*. The Actinaria are very abundant and our collections are numerous. We found but few hydroids and a millespore coral. The Medusæ and Hydro-Medusæ are very abundant in the still waters of Harrington Sound. The Echinoderms are exceedingly interesting and abundant. The Holothuria are represented by the genera *Holothuria*, *Semperia*, *Stichopus*, the last being very abundant. The Asteroidea are few, and are represented by one species of *Asterias* and one of a new genus not yet determined ; the Ophiuroidea by several genera. The Echinoidea are represented by *Cidaris*, *Diadema*, *Hipponæ*, *Echinometra*, *Toxopneustes*, *Mellita* and one new genus. The Crustacea are numerous and exceedingly interesting. Our collections will be studied by Dr. Rankin, who will report on them later.

The Mollusca of the archipelago number, according to Heilprin, about 170 marine forms and thirty terrestrial. Among the cephalopoda are *Octopus* and *Argonauta*. The naked *Aplysia* is fairly abundant, and numerous other naked molluscs are found in Harrington Sound.

The Annelids are not as numerous in the places we searched as we expected, but those we found are new to us and the genera are not yet determined. The sponges are very numerous in genera and plenty in individuals. The Tunicates are exceedingly numerous and offer a rich field for investigations. *Amphioxus* is reported, but we had no opportunity to search for it. The abundance and beauty of the Bermuda fishes is notorious. Dr. Bean is making a study of them, carrying on the work started by his colleague the late Dr. G. Brown Goode. Incidental to the main work of the expedition we undertook to furnish the Aquarium in New York with live specimens of some of these fishes, and thousands of visitors to that institution testify to their beauty and gracefulness. This part of the work was by no means the least interesting. We installed four large tanks and a pumping engine on White's Island, in the harbour of Hamilton, and acclimatised the fish before transferring them to the steamship On board the boat the fish were supplied with running water, thanks to the kindness of the Quebec Steamship Company, and no small part of our success was due to the generous and skilful aid given us by the Chief Engineer, Mr. Ritchie. Under these favourable conditions our loss was slight, and another season will be much less. It is interesting to note that our efforts to bring invertebrates alive failed in every

case but one, though we could keep them in prime condition until we struck the polluted waters of the coast, when they died quickly. Our failures, however, have suggested remedies, and next year we hope to show *Octopus*, *Palinurus*, *Ibacus*, *Aplysia* and the sea-anemones, as well as the fishes. The fishes thrive in the Aquarium, although the water is several degrees cooler than they are accustomed to, and the salinity much less. There would be little difficulty apparently in carrying them from New York across the Atlantic, if that were desirable, under the same conditions that we carried them from Bermuda.

Our hasty survey strengthens the idea of establishing a station, and we are planning to have one in working condition by the summer of 1899, if not before. It will have two stories, the lower given up to aquaria, as at Naples, and open to the public during the winter at a small fee; the upper story will be fitted up for a laboratory, and while under the charge of the University will be open to any one competent to carry on an investigation in botany or zoology. It is not intended to rival any of the stations on the Atlantic coast, but to supplement them, and to afford opportunity to investigators of America and Europe to study the flora and fauna of a tropical horizon with ease and comfort. The healthfulness of the place is testified by the yearly visitation of over two thousand guests who spend the winter months there. Malaria is unknown, as is also prostration by heat. The climate during June and July is not disagreeable, the thermometer rarely going up beyond 82° F.

Another project in hand with the station at the Bermudas is the exploration of the West Indies with the Bermudas as a base. Two lines of steamers connect the islands with the West Indies, and the investigator starting on them equipped from the appliances of the station may make a rapid collecting trip to a desired place, and return to work over his material under the more favourable conditions at the station.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The examination for University Mathematical Scholarship and Exhibition will begin on January 20, 1898.

At the Junior Scientific Club on Friday last, November 19, Mr. A. C. Le Rossignol (Exeter) read a paper on "Nitro-explosives." Mr. H. Balfour (Trinity), exhibited a series showing the ancient and modern use of bones of animals as skates. Mr. N. V. Sedgwick (Ch. Ch.) was in the chair.

The regulations for carrying into effect the provisions of the statute relating to the training of teachers are as follows:—I. To obtain the certificate the candidate shall (1) satisfy the authority appointed by the delegates in practical work done under supervision in Oxford; (2) present a record in writing, satisfactory to the delegates, of lessons prepared and given by him, or her, during the training course in Oxford; (3) have taken a further probationary course of teaching in some school appointed by the delegacy; such course to include not less than one hundred lessons, and the report of this work to be signed by the head master or mistress; (4) pay a fee of 2*l.* 2*s.* when the diploma is awarded. II. In the case of candidates already teachers (with the exception of those who shall have passed, or taken honours at, the second public examination after Trinity Term, 1898), the delegacy will certify that a candidate has satisfied them of proficiency in the practice of teaching, provided that the candidate (1) has taught for a year in a secondary school approved by the delegacy; (2) has attended at least one holiday course held under the authority of the delegacy; (3) has satisfied the persons appointed by the delegacy of his, or her, proficiency in the practice of teaching; (4) shall pay a fee of 3*l.* 3*s.*

A HALL of physics, in connection with Syracuse University, will, it is expected, be built next year, the sum of 5000*l.* having already been subscribed for the purpose.

SIR WILLIAM MACCORMAC, the President of the Royal College of Surgeons, England, has been appointed a Governor of the Mason College, Birmingham, for five years.

THE new chemical laboratory building of the University of Berlin, which is at present in course of erection, will, it is stated, contain four large laboratories and twenty-five research rooms, and accommodate 250 students. Its cost will be about 50,000*l.*

AMONG a number of bequests by the late Sir Thomas Elder, of Glan Osmond and Adelaide, South Australia, are:—4000*l.* to Prince Alfred College, Adelaide; 2000*l.* to Way College, Adelaide; 25,000*l.* to Adelaide University; and 20,000*l.* to the Medical School of Adelaide University.

MANUFACTURERS having at heart the advancement of technical education should emulate the action of Messrs. Brunner, Mond, and Co. This firm voluntarily tax themselves to the extent of one penny in the pound on their works at Anderton, Barton, and the rural portion of Winnington, in the interests of technical education in Cheshire.

AT a meeting of the Council of the Royal College of Surgeons, England, on November 11. Felstead School and Watford Endowed Schools were added to the list of recognised places of instruction in chemistry, physics, and practical chemistry; and the South-west London Polytechnic Institute, which was already recognised for instruction in these subjects, was added to the recognised places of instruction in elementary biology.

THE Court of the Drapers' Company have approved the plans of a new building at Oxford, which will be the future home of the Ratcliffe Library if the authorities at Oxford accept them. The cost of the new structure will be 18,500*l.* The Ratcliffe Library was founded by Dr. Ratcliffe considerably over a century ago, but the space it now occupies will be absorbed by the extension of the medical school. The Drapers' Company, in the interests of education, has undertaken to erect the new building, the plans of which have been prepared for the Company by Mr. T. G. Jackson, R.A.

AMONG recent appointments abroad, we notice the following: Dr. Theodore Curtius, of Bonn, to succeed the late Prof. Victor Meyer at Heidelberg; Mr. G. S. Wilkins to be professor of civil and mining engineering at the University of Alabama, and Dr. John Y. Graham to be professor of biology at the same institution; Dr. Max von Frey, of Leipzig, to be professor of physiology at the University of Zürich; Dr. Kraus to be professor of botany at the University of Halle; Dr. Max Dessoir to be associate professor of psychology at the University of Berlin; Dr. Lothar Heffter to be associate professor of mathematics at the University of Bonn; and Dr. Brikencajer to be associate professor of mathematics at the University of Krakau.

THE extent to which County and County Borough Councils in England are working in connection with secondary schools may be seen in a tabular statement published in the current *Record of Technical and Secondary Education*. The tables go to show that during the year 1896–97, sixty-three local authorities gave direct or indirect assistance to three hundred and twenty-eight individual secondary schools to the extent of 144,871*l.*, this sum including the value of scholarships and exhibitions granted for pupils proceeding from secondary schools to higher institutions. Other ways in which the sum referred to was expended were in capitation grants, for teaching staff, maintenance, apparatus, &c., and buildings.

THE Birkbeck Science Society has just been formed in connection with the Birkbeck Institution, London, and purposes holding meetings on the first and third Saturdays of each month, for the reading and discussion of papers on scientific and philosophical subjects. It is also intended to make frequent excursions to places of scientific interest, especially chemical and physical works. It is further intended to publish a journal, containing abstracts of the papers read before the society, together with reports of the scientific excursions. The first meeting of the Society was held on Saturday, in the Chemical Lecture Theatre of the Institution, when a large number of past and present students were present. The Principal of the Institution, Mr. G. Armitage-Smith, occupied the chair, and after welcoming the Society on behalf of the governing body, made some very appropriate and interesting remarks about the value of scientific study. An interesting and instructive paper on "Cavendish and his Work" was then read by Dr. J. E. Mackenzie. The lecturer started by picturing the state of science at the beginning of Cavendish's work, and traced it down to the present day, showing that the 1 per cent. of gas which always remained after his experiments with air, was in reality the argon discovered by Lord Rayleigh and Prof. Ramsay. The Secretary's report was very encouraging, showing

that although the Society had only been in existence for about three weeks, it now numbered more than seventy members. The next meeting of the Society will take place on Saturday, December 4, when Mr. R. S. Clay will deliver an experimental lecture, entitled "Soap Bubbles."

THE opening meeting of the winter session of the General Medical Council was held on Tuesday, Sir William Turner presiding in the absence of Sir Richard Quain, the president. The chairman read a letter from the president expressing regret at the fact that, though his health had improved, he could not undertake the risk of presiding at the meetings during the present session. In the course of his communication Sir R. Quain referred to the progress that had been made with regard to the question of disciplinary or penal powers exercised by the various licensing bodies. Following the example of the University of Cambridge, the University of Durham had now obtained a charter under which it had the power of taking away any degree from a graduate who had been convicted of a crime for which he had been sentenced to penal servitude or imprisonment. Similar steps, he was informed, were being taken by the Victoria University, its court having decided to make application for the necessary amendment of its charter; so that in a very short time that University also would be in possession of extended powers. In Scotland, also, some further steps had been taken in regard to this question. The Universities of Aberdeen and St. Andrews would, no doubt, be prepared to adopt a course of action similar to that taken by Edinburgh and Glasgow. With regard to the new edition of the "British Pharmacopœia," the arduous and important work of preparation that had occupied about three years, was now well nigh finished, and if the Council accepted the draft that would be placed before them in the course of the present session it might be expected that the work would be published at an early date.

SINCE the passing of the Local Taxation Act (1890), twenty-three municipal science and art and technical schools have been established. In a number of localities (states the *Record*) the technical schools have been, or will be, erected as a part of general schemes which include the provision of other institutions for public or municipal use, for example as free libraries, museums, art galleries, gymnasiums, &c. In several localities, on account of the development of the work since the erection of the technical institutions, considerable extensions have been, or are about to be, made to the buildings; the total sum spent or involved for these extensions in the seven districts amounts to over 33,000*l*. In some cases local science and art and technical schools or classes have been transferred to the respective local authorities for municipal management and control since the passing of the Technical Instruction Act, 1889; in Chesterfield the local technical institution, which was erected at a cost of 13,000*l*., was subsequently purchased by the Corporation for the sum of 4000*l*. In Lancaster a splendid institution was built and fitted up and presented to the Corporation by Sir Thomas Storey, and in Northwich and Winsford sites were secured and technical schools were erected and furnished at the expense of Sir Joseph Verdin, Bart. The total amount of money which has been provided by these means for the erection of schools and institutions in seven of these localities (excluding Lancaster) is as much as 81,000*l*., the schools in Burslem, Lancaster, and Southport serving as permanent memorials of Her Majesty the Queen's jubilee of 1887. Excluding Bridgwater and Lancaster, the total sum involved in the erection of technical schools in the thirty-six boroughs and urban districts not included in the above statement is as much as 331,000*l*.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, November.—The rainfall of October, 1897. This was so exceptionally small that all records received up to date showing a total fall of less than an inch for the month have been tabulated. The lowest values, expressed in inches, are found in the extreme south-east of Kent, ·32; Sussex, ·34; Hants, ·49; Essex, ·51; Suffolk, ·59; Surrey, ·60. At least a quarter of the stations quoted, spread over England and Wales, nearly 240 in number, record less than an inch.—Austrian hydrography. This is a summary of the reports of a comparatively new organisation, dealing with the rainfall of the principal watersheds for the year 1895; the stations number between two and three thousand, and the results are contained in fifteen large folio parts. Each part, except the introductory one, includes a large-scale shaded rainfall map, and the whole work probably surpasses anything of the kind in any other country.

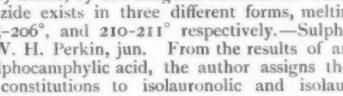
Wiedemann's Annalen der Physik und Chemie, No. 11.—Retardation of spark discharge, by E. Warburg. The period elapsing between the establishment of the necessary difference of potential and the corresponding discharge is called the "retardation." It varies from a few minutes to a fraction of a second, and is due to a non-luminous partial discharge. This preliminary discharge is greatly influenced by ultra-violet light, and also by a magnetic field.—Photo-electric properties of fluorspar and selenium, by G. C. Schmidt. Although fluorspar acquires a positive charge in some parts under the influence of light, and a negative charge in other parts, it only dissipates negative charges under the action of light, and even selenium shows no sign of dissipating a positive charge.—Mutual influence of kathode rays, by J. Bernstein. The apparent repulsion between two kathode beams running side by side is due to some action of the metallic kathode upon the origin of the other beam, and not to any mutual action of projected particles. This may be proved by allowing them to proceed parallel to each other from opposite ends of the tube, when their path remains straight.—On the nature of the salts coloured by kathode rays, by R. Abegg. The coloration of NaCl and KCl salts by kathode rays is not due to the formation of sub-chlorides, since no chlorine is evolved. It is a physical change.—On the carbon electric arc, by R. Herzfeld. The counter E.M.F. produced by the air is not due to the deposition of carbon particles on the kathode, since they may be deflected by a strong electric field without affecting the E.M.F. The growth on the kathode is due to the lack of oxygen necessary for the complete combustion of the carbon.—Conductivity of electrolytes for rapid oscillations, by J. A. Erskine. An oscillator is placed in a basin filled with petroleum, and another dish containing the resonator immersed in the electrolyte is placed on the top of it. The electric resistance of the electrolyte is directly proportional to the thickness required to produce a given amount of damping.—Absorption of electric oscillations by luminescent gases, by E. Wiedemann and G. C. Schmidt. Gases excited to luminescence in a vacuum tube screen other tubes from similar excitation, but flames do not, neither does the dark kathode space. A similar screening is produced by Goldstein's "canal rays."

Meteorologische Zeitschrift, October.—Some results of the five years' observations on the Eiffel Tower, by A. Woeikof. The author compares the daily periods of temperature and wind force for certain selected months; in the winter the minimum wind force at the summit of the tower occurs about the time of the highest daily temperature; while in summer it takes place considerably earlier, about 9h. or 10h. The force then increases gradually until the time of highest temperature, and afterwards more rapidly, until evening. The times of the maxima at the summit and on the ground do not exhibit any decided seasonal range, but in the case of the minima a seasonal range is clearly shown. During May to July the mean time is 1·3 hours earlier than during November to February. At the summit the occurrence of the minimum is earlier in summer than in winter, and the interval is greater, viz. 4·5 hours. An explanation of these phenomena is suggested by Dr. Woeikof.—The total variation of temperature in the Arctic and Equatorial oceanic climate, by A. Woeikof. The variations considered are those shown by hourly observations for certain representative months for Batavia and Sagastyr (mouth of the Lena). Dr. Woeikof finds that summer and spring have nearly the same variation in the Equatorial and Arctic climate, and that the uniformity of summer temperature in polar regions is exhibited by this investigation. The total variation is even somewhat smaller than at Batavia, while the non-periodic portion is not twice as great.—Dr. W. Trabert contributes an article on the extraordinary rainfall in Austria between July 26 and 31 last, which caused destructive floods in several districts.—Among the smaller notices, Prof. G. Hellmann gives a formula for the conversion of Fahrenheit to Centigrade degrees, which is simpler than that usually employed, viz.: to half the difference between the reading and 32° add the tenth and hundredth part of this difference, *e.g.* $\frac{74 - 32}{2} = 21 + 2{\cdot}1 + {\cdot}2 = 23°{\cdot}3$, the value given in the tables. For an explanation of the rule we refer our readers to the original notice.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, November 4.—Prof. Dewar, President, in the chair. The following papers were read :—On the properties of liquid fluorine, by Profs. Moissan and Dewar (see page 82).—The liquefaction of air and the detection of impurities, by Prof. Dewar. The author has devised an apparatus for ascertaining the proportion of any gas in air that is not condensible at about −210° C. under atmosphere pressure, or is not soluble in the liquid air produced; the air to be examined is cooled in a tube immersed in a reservoir, which can be continuously replenished with liquid air boiling under diminished pressure. The gas which does not condense under these conditions can be subsequently collected and examined, or the liquefied portion of the air can be boiled in the condensing tube and the gas collected over mercury. On thus condensing 70 litres of the gas issuing from the King's Well at Bath, which Rayleigh has shown to contain 0·12 per cent. of helium by volume, a liquid was obtained which, when boiled, gave off first a gas containing about 50 per cent. of helium. It is concluded that helium is less soluble in liquid nitrogen than hydrogen is in liquid air, and that by proceeding as above helium can be separated from a gas in which it is present to the extent of only one part per thousand; it would seem, further, that hydrogen and helium have about the same volatility.—The absorption of hydrogen by palladium at high temperatures and pressures, by Prof. Dewar. The author, after summarising his previous work on the absorption of hydrogen by palladium, describes experiments made with the object of ascertaining whether the metal absorbs the gas at high temperatures and pressures; palladium does not absorb hydrogen under atmospheric pressures at above 145° C. A rod of palladium, weighing 119 grams, and occupying 10 c.c., was placed in a gas-tight steel cylinder, connected with a manometer, a compressed hydrogen cylinder, and a blow-off cock; the vessel containing the palladium could be heated in a bath of fusible metal. It was found that the palladium absorbed over 300 times its volume of hydrogen at 420° under 80 atmospheres pressure, whilst it absorbed 300 times its volume of the gas at 500° under 120 atmospheres. The experiments have led to the deduction of a number of interesting thermal constants for the absorbed hydrogen.—On some yellow vegetable colouring matters, by A. G. Perkin. The *Rhus rhodanthema*, a tree indigenous to New South Wales, contains fisetin, $C_{15}H_{10}O_6$, and a glucoside of fisetin, $C_{36}H_{30}O_{16}$ resembling fustin, the fisetin glucoside present in *R. cotinus*.—Naphthylureas, by G. Young and E. Clark. The mononaphthylureas may be prepared by treating the naphthylamine hydrochlorides with potassium cyanate, and readily become converted into the symmetrical dinaphthylureas. — Benzoylphenylsemicarbazide, preliminary notice, by G. Young and H. Annable. Benzoylphenylsemicarbazide exists in three different forms, melting at 202–203°, 205–206°, and 210–211° respectively.—Sulphocamphylic acid, by W. H. Perkin, jun. From the results of an investigation of sulphocamphylic acid, the author assigns the following probable constitutions to isolauronolic and isolauronic acid respectively :—



Geological Society, November 3.—Dr. Henry Hicks, F.R.S., President, in the chair.—The Secretary announced that Lady Prestwich had presented to the Society a half-length portrait in oils of the late Sir Joseph Prestwich, painted by Mr. W. E. Miller.—Mr. W. W. Watts gave details of some interesting geological features recently exposed at the new sewerage works at Carshalton, Surrey, now being made by the Urban District Council. These excavations are situated at a spot which on the Geological Survey map is coloured as London clay; and the features of the ground fully justified this colouring. The excavations, however, have shown that there are loamy and sandy beds of a light yellow colour, some 14 or 15 feet in thickness, and apparently occupying a hollow in the London clay. At the base these sandy beds become dark and clayey in some places, and include flints and pebbles, while below this is the London clay. In the dark pebbly layer were found a large skull, a piece of a tusk, and a number of smaller bones, which Mr. E. T. Newton has determined to be a piece of elephant-tusk, the skull (31 inches long) of *Rhinoceros antiquitatis* with some of its limb-bones; while the smaller bones represent two or perhaps three horses. Although the teeth of the rhinoceros are wanting, the skull is otherwise very perfect; and, bearing this in mind, as well as the fact that certain of the limb-bones were also found, and that *Elephas* is represented by the tusk, and all three (it is said) at a depth of 14 or 15 feet, little room is left for doubting that we have here at Carshalton a Pleistocene deposit of a somewhat unusual character, and at a spot where it was not before suspected. Mr. Whitaker, who was responsible for the geological mapping of this district, pointed out how the general configuration of the district gave no clue to the presence of this deposit of loamy sand, which occurred on a gentle slope, and that even now it was only possible to mark it on the map as an oval patch round the excavations with uncertain boundaries. The drift shown, moreover, differs from that of the neighbourhood in that the latter is essentially gravel, while the former is sand, with loamy beds, but, as a rule, not stony, so that there are no surface-indications of gravel. The mammalian remains are now preserved in the Museum of Practical Geology.—Lieut.-General McMahon having taken the chair, the President made a communication regarding very similar deposits to those above described occurring in north-western Middlesex. Some years ago he described sections in glacial drift on the Hendon plateau exposed during sewerage operations. More recently the sewers have been carried on at lower levels between Hendon and Edgware, and numerous remains of the mammoth and rhinoceros have been found resting on an eroded surface of London clay, and covered over by about 7 feet of stratified sands and gravels and brick-earth. These deposits were found to spread out for considerable distances over the plain, and to be cut through also by the Silke stream, a tributary of the Brent. This area has hitherto been supposed to consist almost entirely of London clay, but the sections have now shown that the brick-earth which, in many respects, simulates the London clay, is underlain by deposits which must be classed as of Pleistocene age.—The President then resumed the chair, and Mr. H. B. Woodward called attention to a block of quartzite from Criccieth in Carnarvonshire, which had been sent for exhibition by Mr. G. J. Day. The rock contained a band of disrupted clayey material which presented on the surface of the block a rude resemblance to hieroglyphics. He thought that the curious structure had been produced on a sea-shore bounded by clay cliffs, where a film of mud had been spread over the sands; and that the mud had dried and curled up before other layers of sand had been accumulated on the top of it. Similar phenomena might be produced at the present day on the Cromer coast, where thin films of mud were in places spread over the sands of the sea-shore. It had been suggested that the appearances in the Criccieth stone might have been produced in the original deposit during the irregular solidification of the sand and its included layer of mud. The rock itself was regarded by the President as probably derived from the Harlech grits, in which he had observed somewhat similar features.—Mr. Bauerman, as one of the three delegates appointed by the Council on behalf of the Society to attend the recent International Geological Congress, held at St. Petersburg, gave a short account of the work of the Congress, dwelling more particularly on the excursion to the Ural Mountains, in which he had taken part.—The following communication was read: A contribution to the palæontology of the decapod Crustacea of England, by the late James Carter. This paper deals mainly with the Brachyura. The author describes several new species belonging to the genera *Nephrops*, *Gebia*, *Homolopsis*, *Ranina*, *Mithracia*, *Neptunus*, *Actæopsis*, and *Goniocypoda*. The genera *Gebia*, *Ranina*, and *Neptunus* have not been previously recorded from British rocks. *Diaulax* is for the first time identified from the Tertiary strata, a single specimen having been found in the Middle Headon. *Platypodia Oweni*, Bell, is now referred to the genus *Diaulax*; and *Palæocorystes Broderipi*, Bell, to the genus *Eucorystes*. As a result of the careful study of large series of specimens in various collections, the author is able to give much additional information concerning the morphology of several species.

Zoological Society, November 16.—Dr. Albert Günther, F.R.S., Vice-President in the chair.—The Secretary read some notes, made by Mr. A. Thomson, Head-Keeper, on the breeding of two species of Glossy Ibis (*Plegadis guarauna* and *P. falcinellus*) in the Society's Gardens, and made remarks on the differences in their plumages. The Secretary also exhibited an

egg of the Brazilian Cariama (*Cariama cristata*), laid in the Society's Gardens, and read some notes made by Mr. A. Thomson, Head-Keeper, on the breeding of this bird.—Mr. Sclater gave an account of some of the more interesting animals observed by him during a recent visit to the Zoological Gardens of Cologne, St. Petersburg, Moscow and Berlin.—A note was read from Messrs. Oldfield Thomas and R. Lydekker, stating that during the preparation of their paper on the dentition of the Manatee, published in the last part of the *Proceedings*, an important memoir by Dr. C. Hartlaub on the subject, in which some of their conclusions had been anticipated, had been overlooked.—Mr. R. Lydekker, F.R.S., exhibited a skin of the Blue Bear of Tibet (*Ursus pruinosus*), described and figured in the Society's *Proceedings* (*P. Z. S.*, 1897, p. 412, pl. xxvii.), and a sketch of the Altai Deer (*Cervus eustephanus*) taken from a specimen in the menagerie of the Duke of Bedford at Woburn Abbey.—A communication by Mr. George P. Mudge, "On the Myology of the Tongue of Parrots," was read by the author. Specimens of six different species of the *Psittacidæ* had been examined, and a detailed description of the muscles of each of them was given in this paper.—A communication from Mr. E. T. Browne, "On British Medusæ," was read. It was a continuation of a previous paper, entitled "On British Hydroids and Medusæ," published in the *Proceedings* for 1896. Eight species were treated of at length.—Dr. A. G. Butler enumerated the species (138 in number) contained in three consignments of butterflies collected in Natal in 1896 and 1897 by Mr. Guy A. K. Marshall, and gave the dates of the capture of the specimens, the localities where they were found, and other interesting notes concerning them. One new genus (*Chrysoritis*) and one new species (*Cacyreus marshalli*) were described. A communication from Mr. Edgar R. Waite, of the Australian Museum, Sydney, "On the Sydney Bush-Rat (*Mus arboricola*, W. S. Macleay)," was read. It treated of the habits of the animal in a wild state and of its anatomical characters.—A third portion of a paper on the spiders of the Island of St. Vincent, by M. E. Simon, was communicated by Dr. D. Sharpe, F.R.S., on behalf of the committee for investigating the fauna and flora of the West Indian Islands. Of the species enumerated forty-six were described as new, which included three new genera, viz. *Mysmenopsis*, *Homalometa*, and *Mesobria*.—Prof. Alfred Newton, F.R.S., exhibited some specimens of new or rare birds' eggs, and read some notes upon them. Amongst these were the first properly authenticated examples of the eggs of the Curlew-Sandpiper (*Tringa subarquata*) obtained by Mr. Popham on an island in the mouth of the Jenisei River in July last. Other eggs exhibited were those of *Turdus varius*, *Chasiempis sandvicensis*, *Himatione virens*, *Emberiza rustica*, and *Podoces panderi*.

Linnean Society, November 4.—Dr. A. Günther, F.R.S., President, in the chair.—Mr. F. G. Jackson, leader of the Jackson-Harmsworth Polar expedition, exhibited a series of lantern-slides, illustrating some zoological observations of the expedition, the most noteworthy being views of the hibernaculum of the polar bear and of the breeding haunts in Franz Josef Land of the ivory gull (*Pagophila eburnea*), the eggs of which were also shown.—Mr. H. Fisher, botanist of the expedition, brought for exhibition a collection of plants made by him in Franz Josef Land, the consideration of which was deferred for want of time.—Mr. Reginald Lodge exhibited some lantern-slides of marsh birds, their nests, eggs, and young, from photographs recently taken in Spain and Holland.—Sir John Lubbock, Bart., M.P., read a paper on the attraction of flowers for insects, which dealt chiefly with the points raised in three recently published memoirs by Prof. Plateau, who had attempted to show that the scents and not the colours of flowers serve to attract insects. Sir John Lubbock explained that his view, like that of Sprengel and Darwin, was that to insects flowers were indebted for both their scent and colour. Not only had the present shapes and outlines, colours, the scent, and the honey of flowers been gradually developed through the unconscious selection exercised by insects, but this applied even to minor points, such as the arrangement of lines, and the different shades of colour. Prof. Plateau had recorded a series of experiments on the dahlia, in which he showed that bees come to these flowers even when the ray-florets have been removed. Discussing this point, Sir J. Lubbock said it was somewhat singular that he should have selected as proving that insects are entirely attracted by scent a flower which had, so far as he knew, no scent at all. He gave several reasons for disputing the conclusions drawn by Prof. Plateau from his experiments, and recorded others made by himself which refuted them. He had selected species of flowers in which the scent is in one part and the coloured leaves in another, as, for instance, the *Eryngium amethystinum*. This flower is surrounded by brilliant blue bracts; and he found that if the two parts were separated, the bees came more often to the bracts than they did to the flowers themselves. He maintained, therefore, that the observations of Prof. Plateau did not in any way weaken the conclusions which had been drawn by Sprengel, Darwin, and others, and that it was still clear that the colours of flowers serve to guide insects to the honey, and in this way secure cross-fertilisation.—Mr. W. C. Worsdell communicated a paper on transfusion-tissue, its origin and functions in the leaves of Gymnospermous plants.

PARIS.

Academy of Sciences, November 15.—M. A. Chatin in the chair.—Reaction of hydrogen upon sulphuric acid, by M. Berthelot. Sulphuric acid absorbs hydrogen completely at 250°, and even in the cold, during two months, 75 per cent. of the hydrogen present was absorbed, with production of a corresponding amount of sulphur dioxide. This reaction does not take place with the diluted acid. A thermo-chemical study shows that the dilution of the acid changes the thermal sign of the reaction.—Influence of oxygen upon the decomposition of the hydracids by metals, and especially by mercury, by M. Berthelot. Although pure hydrogen chloride may be kept over mercury for several years without change, in the presence of oxygen there is a slow absorption, as a result of which the acid is wholly absorbed according to the equation

$$4HCl + O_2 + 4Hg = 2Hg_2Cl_2 + 2H_2O.$$

A similar reaction takes place between mercury, hydrogen sulphide, and oxygen. In both these cases there is an evolution of heat during the reaction.—Direct action of sulphuric acid upon mercury at the ordinary temperature, by M. Berthelot. Mercurous sulphate and sulphur dioxide are produced after long standing at ordinary temperatures.—Observations on the swarm of shooting stars, made at the Observatory of Paris, during the nights of November 13–14, 14–15, 1897, by M. Lœwy.—Influence of surfusion upon the freezing point of solutions of potassium chloride and sugar, by M. F. M. Raoult. The experiments quoted now definitely show that the molecular lowering of the freezing points for potassium chloride and sugar have limiting values agreeing with the predictions of Arrhenius.—On the integration of the equations of heat, by M. Le Roy.—Observations of the shooting stars at the Observatory of Meudon, by M. Hansky.—Observations on this communication, by M. J. Janssen.—The mechanical principles involved in the practical application of the mercury bath as a means of obtaining a true vertical, at the Paris Observatory, by M. Maurice Hamy.—On a generalised displacement in which all points describe spherical trajectories, by M. Ernest Duporcq.—On the theory of complete functions, by M. Erik Schou.—On the transmission of energy at a distance. Application to rotatory polarisation, by M. André Broca.—On the coefficients of expansion of gases, by M. A. Leduc. From the experimental results on the densities of gases previously given, a formula is derived for the true coefficient of expansion at 0° C. under a pressure of π cm. of mercury. This formula is applied to some twenty-three gases, and the figures obtained compared with the experimental results of M. P. Chappuis.—Action of water upon phosphorus trichloride, by M. A. Besson. Evidence is adduced of the existence of a phosphorus oxychloride, $POCl$, analogous to $NOCl$. It is formed by the action of a small quantity of water upon an excess of phosphorus trichloride, according to the equation

$$PCl_3 + H_2O = 2HCl + POCl,$$

and is separated from the excess of the trichloride, by distillation in a vacuum. $POCl$ forms a waxy solid, of the consistence of paraffin, which is insoluble except in PCl_3. The yield is very small, never exceeding 0·2 to 0·5 gr. per kilogram of PCl_3 used.—On cerium, by M. O. Boudouard. By fractional crystallisation and precipitation of the acetate and sulphate of cerium it is found that cerium oxide is contaminated with small quantities of another earth possessing a lower atomic weight.—On the preparation of strontium sulphide by means of hydrogen sulphide and strontia or strontium carbonate. Influence of temperature,

by M. José Rodriguez Mourelo.—Production of volatile fatty acids from the waters used in the *désuintage* of wool, by MM. A. and P. Buisine. The acids obtained include acetic, propionic, butyric, valerianic, and caproic, the two first being the chief constituents.—On the decomposition of chloroform, bromoform, and choral by aqueous potash, by M. A. Desgrez. An aqueous solution of potash attacks chloroform slowly, with production of carbon monoxide. Light hastens the reaction. Bromoform behaves similarly, except that being much less soluble in water than chloroform, the action is less. Iodoform is not affected under the same conditions.—On silver cyanamide, by M. Paul Lemoult. A thermo-chemical paper.—Observations on the crabs of the family of the Dorippidia, by M. E. L. Bouvier. A contribution to the study of the evolution of the deep-sea crabs. The close analogy between the species found in West Indian seas and the Eastern Pacific leads to the conclusion that at no very distant period the oceans were connected at Panama.—On a new type (*Metchnikovella*) of organisms parasitic to *G. spionis*, Köll, by MM. Maurice Caullery and Félix Mesnil.—On a bacterium pathogenic for Phylloxera and for certain Acarians, by M. L. Dubois.—On the determination of sex in hemp, by M. Molliard. From a fixed number of hemp seeds, an alteration of the conditions of growth may cause an alteration in the proportion of male and female plants produced.—Action of mineral salts upon the form and structure of the lupin, by M. Dassonville. The presence of dissolved salts, among other effects, increases the number and diameter of the vessels, and retards lignification in all the organs of the lupin.—On the composition of the oat, by M. Olivier de Rawton.—Composition of buck-wheat, by M. Balland.—On the use of calcium carbide against black rot, by M. G. Rodier.

NEW SOUTH WALES.

Linnean Society, September 29.—Dr. J. C. Cox, Vice-President, in the chair.—Revision of the Australian *Curculionidæ* belonging to the subfamily *Cryptorhynchides*, Part i., by Arthur M. Lea. The subfamily *Cryptorhynchides* being in considerable confusion, it is proposed to examine and redescribe all the Australian genera and species referred to it. The genus *Porapterus* is treated of in the present communication, seventeen species being described as new.—On a new species of *Eucalyptus* from the Sydney district, by Henry Deane and J. H. Maiden. This is a tree of about thirty feet in height, with scaly bark and red timber. The seedling-leaves are ovate to ovate-lanceolate and always alternate. The veins and midribs are reddish and conspicuous. The transverse veins are numerous and fine, making an angle with the midrib of about 50°. The fruits are nearly hemispherical, with a slight tendency to constriction of the orifice, about four lines long by three lines deep, with a sunk rim. The anthers open by pores, showing the affinity of the species, in this direction, to *E. hemiphloia*, and the "Boxes." Its bark bears a superficial resemblance to that of *E. corymbosa*, and, because of its scaly nature, the name of *E. squamosa* is proposed for it.—Descriptions of some new Araneidæ of New South Wales, No. 8, by W. J. Rainbow. Ten new species are described and figured, of which four are referable to the genus *Epeira*, three to *Argiope*, and one each to *Dicrostichus*, *Cheiracanthium*, and *Attus*. In addition to these, numerous specimens of architecture of spiders are described, and some figured, the families illustrated being the *Epeiridæ*, *Drassidæ*, *Attidæ*, and *Thomisidæ*.—Note on the genus *Aphritis*, Cuv. and Val., by J. Douglas Ogilby. The author contends that whereas five different fishes have been assigned to the genus *Aphritis*, C. and V., by various authors, these are referable to but three distinct species, each of which represents a monotypic genus; he distributes them as follows: *A. porosus* and *A. undulatus* lege *Eleginops maclovinus* (C. and V.), Gili; *A. urvillii* and *A. bassii* lege *Pseudaphritis urvillii* (C. and V.); *A. gobio*, Gnth., differs greatly from *Pseudaphritis*, and must receive a new generic name. He concludes by suggesting that *Eleginus bursinus*, C. and V., is identical with *P. urvillii*, in which case our species would have to be called *Pseudaphritis bursinus*.—Notes on the species of *Cypræa* inhabiting the shores of Tasmania, by C. E. Beddome.

AMSTERDAM.

Royal Academy of Sciences, September 25.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Hoek on the results of an inquiry, made by order of Government, into the practice of fishing with so-called "ankerkuilen" (large tow-nets not unlike those employed in the Thames estuary for the whitebait-fishing), used in close time (April 1–June 15), in the mouth of the river, just below the limit of the farmed-out part, particularly with regard to our knowledge of the habits of the salmon, its migrations, &c.—Prof. Suringar presented a fifth contribution to the knowledge of the Melocacti, as a sequel to previous papers. The author showed the skeleton and a photograph of a specimen of *Melocactus humili* from Venezuela, described by himself in 1889, and seeds of which he sent at the time to the firm of Damman and Co., near Naples. It seems that the culture of this plant, which does not succeed in hothouses in North and Middle Europe, might be tried with advantage in the sunny climate of the South Italian coast, exposed to sea-winds. Prof. Suringar exhibited a live specimen, now seven years old, raised from the seed by the above firm, and which has already blossomed and borne fruit. With the exception of a slight difference in size and shape, the mother- and the daughter-plant are very similar. In the colony itself, too, the culture will be tried, that it may be possible to send culturable specimens over from there without detriment to the natural flora. The author exhibited photographs and gave a description of five new genera, received from Curaçao. The berries of these specimens, which have developed themselves on the plants in tolerably large numbers after the arrival of the latter, will be sent back to the colony, together with those of some known genera, received at the same time and determined in Amsterdam, to be sown there, so that the seedlings will at once go by their right names. In conclusion the author presented for inspection the first part of the Iconography announced some time back and published by the firm of E. J. Brill at Leyden, as the third volume of the "Musée Botanique" and entitled "Illustrations de Melocactus," with reproductions of photographs and coloured plates of the thorns, flowers and fruits.—Prof. Lorentz on the partial polarisation of the light emitted by a source in a magnetic field. The author showed how this phenomenon (discovered by Egoroff and Gorgiewsky) may be explained by taking into account the absorption which the rays of one part of the flame undergo in the other, this absorption being modified when the periods of the vibrations are changed by the Zeeman effect. In support of this view the author described an experiment in which the light of a sodium-flame which is placed outside the field, is found to be partially polarised after it has passed through a similar flame standing between the poles.—Prof. van der Waals on the graphic representation of equilibriums by means of the ζ-function. The author observed that at a given pressure and temperature, ζ has three values, and that consequently in general a surface is obtained, consisting of three sheets. Coexisting equilibriums exist if a common tangent plane to points either of the same sheet or of different sheets is possible. Increased pressure causes the heterogeneous region to decrease if the mixing is accompanied by contraction, and conversely. Similarly a rise of temperature causes the heterogeneous region to decrease if a supply of heat is required for the mixing, and conversely.—Prof. Behrens read a paper on mixture crystals of $KMnO_4$ with $KClO_4$ and of Ag_2CrO_4 with Ag_2SO_4, which may serve to prove the presence of perchloric and chromic acid. That these crystals are not discoloured by saturated solutions of $KClO_4$ and of Ag_2SO_4, must not be explained by assuming the crystals to be impenetrable, as enclosures are dissolved under similar circumstances.—Prof. Behrens also dealt with micro-reactions of free sulphuric acid, free ammonia and free alkalis. The first is owing to the formation of quinineherapatheite, the second to the formation of palladoammonium chloride. To detect KOH and NaOH together, the solubility of $PbCrO_4$ in caustic alkalis may be made use of; if they are to be separated at the same time, niobic acid hydrate is the best reagent. With KOH it yields a transparent solution, with NaOH colourless needles and rods. Antimonic acid hydrate too easily forms difficultly soluble salts with KOH.—Prof. Martin read a paper on the geology of the Moluccas, in connection with a work published by himself, supported by Government, and entitled "Reisen in den Molukken, in Ambon, den Uliassern, Seran (Ceram) und Buru, Geologischer Teil." A large portion of Ambon is of volcanic origin, and contains the continuation of the chain of volcanoes in Halmahera; Wawani in Ambon had an eruption as late as 1674. On the other hand, Wallace's opinion that Buru and the north-western part of Seran (Ceram) are volcanic, is incorrect. The author ascribed the eruptions in Halmahera, Ternate and Ambon to lateral displacements in the earth's crust, for in the most recent geological part terrific elevations took place; in Ambon, for

instance, the new reef chalks are situated as high as 480 m. above the sea-level. Volcanic eruptions and elevations are evidently intimately connected in those regions.—Prof. van der Waals presented on behalf of Dr. D. F. Tollenaar, for publication in the *Proceedings*, a paper on "Deflection and reflection with two kathodes." The phenomena occurring when two kathodes are used, and which were described in a previous paper, may be explained in a simple way if the kathode rays are assumed to consist of negatively-charged particles, which are emitted with great velocity Adopting Schuster's formula for the potential fall in the proximity of a kathode, the course of such a particle, near a kathode, can be calculated. In this way the following results are arrived at: (1) behind the deflecting kathode the kathode rays cut each other, and so give rise to a surrounding sheet of light; (2) if the two kathodes emit their rays towards each other, then the rays of one kathode are partly so strongly deflected by those of the other as to be reflected to the emitting kathode; (3) with each of the two kathodes these reflected rays give rise to a second enclosing sheet of light and a corresponding deflection figure; (4) if the two kathodes are made to be of different intensity, the sheet of deflection formed by these reflected rays becomes larger towards the less intense kathode. This sheet of deflection, however, is not an ordinary Goldstein macro-surface, but might be called a pseudo macro-surface.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 25.

ROYAL SOCIETY, at 4.30.—On the Geometrical Treatment of the "Normal Curve" of Statistics, with especial reference to Correlation, and to the Theory of Error: W. F. Sheppard.—Mathematical Contributions to the Theory of Evolution. IV. On the Probable Errors of Frequency Constants, and on the Influence of Random Selection on Variation and Correlation: Prof. K. Pearson, F.R.S., and L. N. G. Filon.—On Certain Natural Media for the Cultivation of the Bacillus of Tubercle: Dr. A. Ransome, F.R.S.—Further Note on the Transplantation and Growth of Mammalian Ova within a Uterine Foster-mother: Walter Heape.—Further Observations upon the Comparative Physiology of the Suprarenal Capsules: Swale Vincent.—Summary of Prof. Edgeworth David's Preliminary Report on the Boring at Funafuti: Prof. T. G. Bonney, F.R.S. —On the Determination of the Indices of Refraction of Various Substances for the Electric Ray. II. Index of Refraction of Glass: Prof. J. C. Bose.—On the Influence of the Thickness of Air-Space on Total Reflection of Electric Radiation: Prof. J. C. Bose.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein. (Continuation of Discussion.)

CAMERA CLUB, at 8.15.—Photographic Action writ large: a Kurveylinear Conversation on Corn: Prof. Armstrong, F.R.S.

LONDON INSTITUTON, at 6.—Acetylene: Prof. Vivian Lewes.

FRIDAY, NOVEMBER 26.

PHYSICAL SOCIETY, at 5.—Upon the Failure of German Silver and Platinoid Wires: Rollo Appleyard.

SATURDAY, NOVEMBER 27.

ESSEX FIELD CLUB (at Buckhurst Hill), at 7.—The Entomostraca of Epping Forest: D. J. Scourfield.—Report on Conference of Delegates of Corresponding Societies at Toronto: Prof. R. Meldola, F.R.S.

MONDAY, NOVEMBER 29.

SOCIETY OF ARTS, at 8.—Gutta-Percha: Dr. Eugene F. A. Obach.

IMPERIAL INSTITUTE, at 8.30.—Kafiristan: Sir George S. Robertson.

INSTITUTE OF ACTUARIES, at 5.30.—Address by the President.

TUESDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

ZOOLOGICAL SOCIETY, at 8.30.—On Regeneration of the Legs in the *Blattidæ*: H. H. Brindley.—On a Gigantic Sea-Perch (*Stereolepis gigas*): G. A. Boulenger, F.R.S.—Description of a New Tortoise of the Genus *Sternothærus*: G. A. Boulenger, F.R.S.—Remarks upon a Mountain Reedbuck from the Eastern Transvaal: F. V. Kirby.

INSTITUTION OF CIVIL ENGINEERS, at 8.—On the Law of Condensation of Steam: Hugh L. Callendar, F.R.S., and John T. Nicolson.

WEDNESDAY, DECEMBER 1.

SOCIETY OF ARTS, at 8.—The American Btcycle—the Theory and Practice of its Making: Dr. Leonard Waldo.

GEOLOGICAL SOCIETY, at 8.—A Revindication of the Llanberis Unconformity: Rev. J. F. Blake.—The Geology of Lambay Island, Co. Dublin: C. I. Gardiner and S. H. Reynolds.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, DECEMBER 2.

LINNEAN SOCIETY, at 8.—On the Anatomy of *Caudina coriacea*: Prof. Arthur Dendy.—On some Desmids from the United States: W. West and G. S. West.——Exhibitions: Specimens of Galls of *Cecidomyæ*: Prof. J. B. Farmer.—An Egg of *Echidna*: Martin Woodward.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—On Collie's Space-Formula for Benzene: Dr. F. E. Matthews.

CAMERA CLUB, at 8.15.—Photomicrography: Dr. Spitta.

FRIDAY, DECEMBER 3.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Permanent Way: its Construction and Relaying: Grote Stirling.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Agricultural Chemistry: R. H. Adie and T. B. Wood, 2 vols. (K. Paul).—La Face de la Terre: Prof. E. Suess; traduit E. de Margerie, Tome I (Paris, Colin).—Leitfaden für Aquarien-und Terrarienfreunde: Dr. E. Zernecke (Berlin, Schmidt).—Die Moorbrücken im Thal der Sorge auf den Grenze Zwischen Westpreussen und Ostpreussen: H. Conwentz (Danzig, Bertling).—The Story of a Red Deer: Hon. J. W. Fortescue (Macmillan).—The Gallinaceous Game Birds of North America: D. G. Elliot (Suckling).—Practical Forestry: Prof. C. E. Curtis, 2nd edition (Lockwood).—The Hope Reports: edited by Prof. Poulton, Vol. I (Oxford).—Recherches Experimentales sur quelques Actinomètres Electrochimiques: Dr. H. Rigollot (Paris, Masson).—Le Culture des Mers en Europe: G. Roché (Paris, Alcan).—Sixteenth Annual Report of the Bureau of American Ethnology (Washington).—The Foundations of Scientific Agriculture: Prof. S. Cooke (Longmans).—A Text-Book of General Botany: Dr. C. C. Curtis (Longmans).—With Nature and a Camera: R. Kearton (Cassell).—La Tuberculose et son traitement hygiénique: P. Merklen (Paris, Alcan).—Pflanzenphysiologie: Dr. W. Pfeffer, Zweite Auflage i. Band (Leipzig, Engelmann).—Kollektivmasslehre: G. T. Fechner, herausgegeben von G. F. Lipps (Leipzig, Engelmann).—Tafeln und Tabellen zur Darstellung der Ergebnisse Spectroskopischer und Spectrophotometrischer Beobachtungen: Prof. T. W. Engelmann (Leipzig, Engelmann).—Observations on the Coloration of Insects: B. von Wattenwyl, translated by E. J. Bles (Leipzig, Engelmann).—Beschreibung der Hauptmethoden welche bei der Bestimmung der Verbrennungswärme: W. Longuinine (Berlin, Friedländer).—Elementary Drawing; E. M. Hallowell (Macmillan).—Zoological Record, 1896 (Gurney).—First Book of Physical Geography: Prof. R. S. Tarr (Macmillan).—Compositions d'Analyse, Cinématique, Mécanique et Astronomie: Prof. E. Villié, troisième partie (Paris, Gauthier-Villars).—Laboratory Tables for Qualitative Analysis, 2nd edition (Manchester, J. E. Cornish).

PAMPHLETS.—Das Wachstum des Menschen: Dr. F. Daffnfr (Leipzig, Engelmann).—Observations on a Collection of Papuan Crania: G. A. Dorsey (Chicago).—A Discussion of the Rainfall of South Africa during the Ten Years 1885–94: Dr. A. Buchan (Cape Town).

SERIALS.—Journal of the Franklin Institute, November (Philadelphia).—Science Progress, October (Scientific Press).—Journal of the Academy of Natural Sciences of Philadelphia, 2nd edition, Vol. xi. Part I (Philadelphia).—Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, 1896 October-December, 1897 April-June (St. Pétersbourg).—Chambers's Journal, Christmas (Chambers).—Himmel und Erde, November (Berlin).

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